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Volume 25 JANUARY, 1948 Number 1

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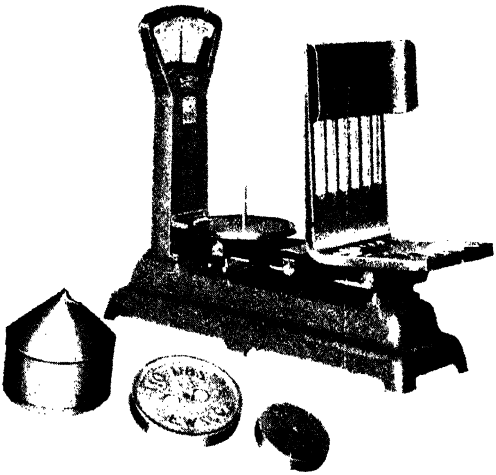

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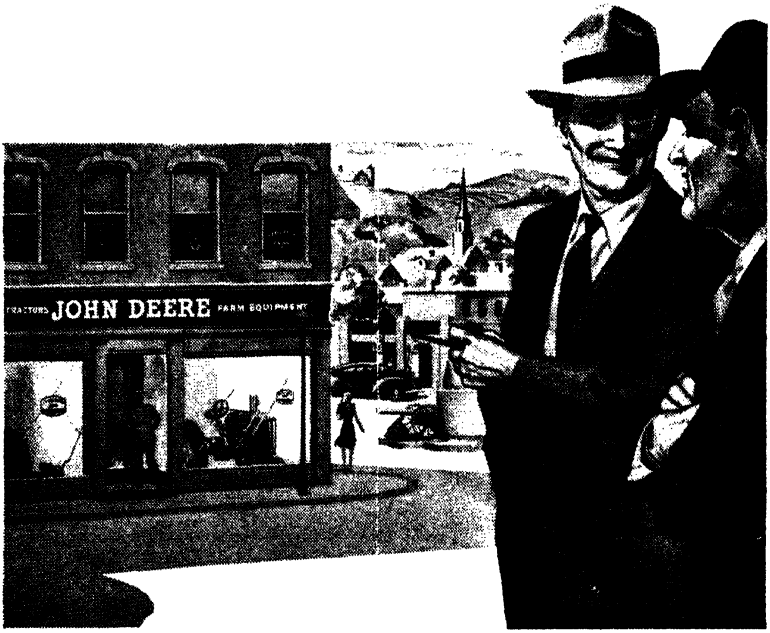

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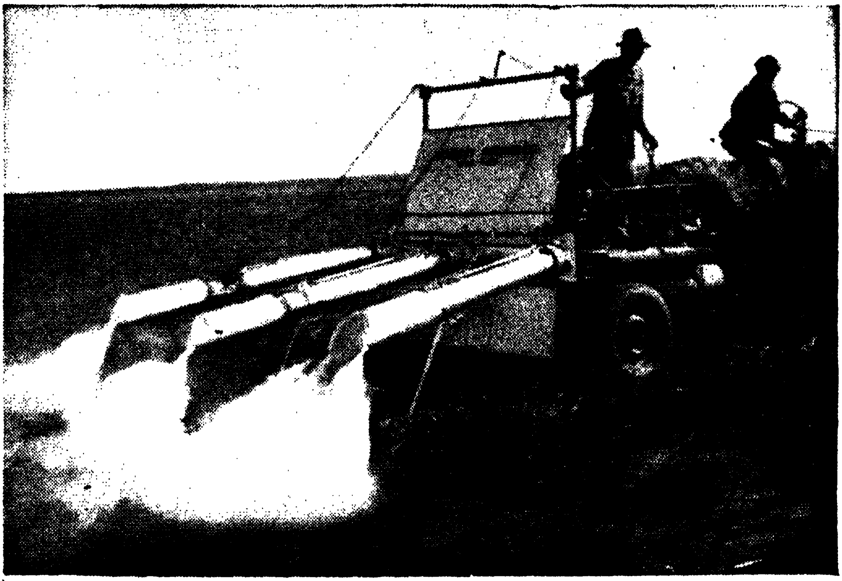

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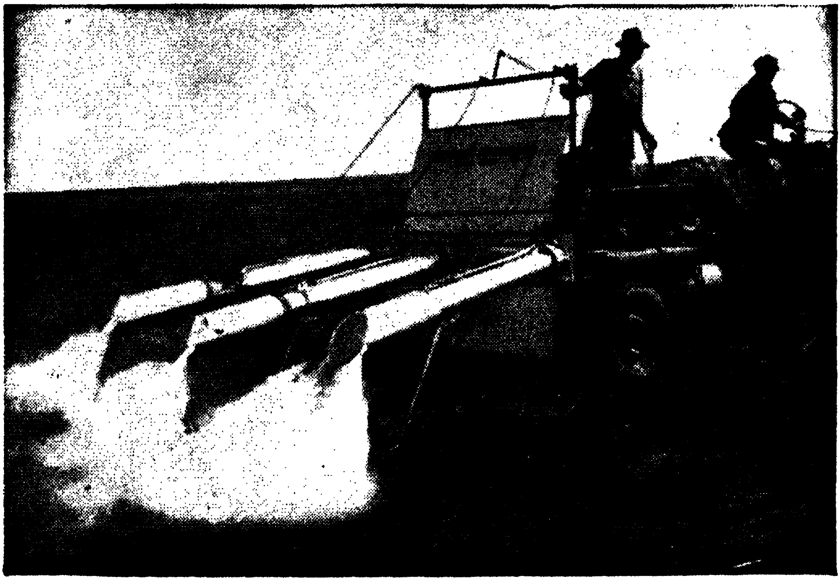

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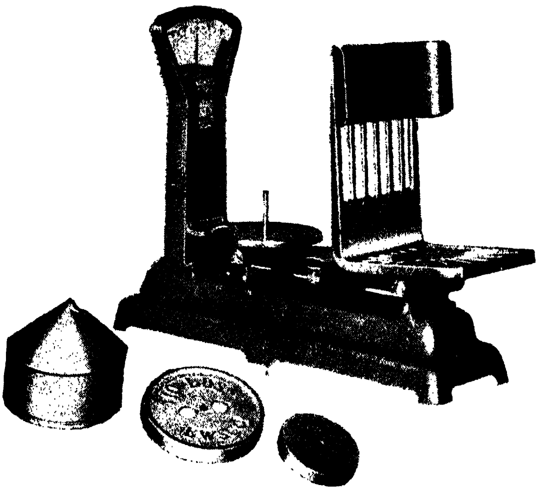
Why Prepackaging is Replacing Bulk Selling

Bulk selling of potatoes has always been freighted with tremendous wastes in shipping, wholesale distribution and retail costs. With this method of handling, quality has been only fair to poor and service in the retail outlet practically non-existent. Prepackaging has changed this by eliminating the major wastes in shipping and handling costs . . . improving quality through proper selection and modern refrigeration . . . facilitating efficient self-service of pre-weighed, pre-priced potatoes, a custom with which the customer is familiar in all other food products. EXACT WEIGHT Scales were one of the pioneers in this great change . . . are today the most popular predetermined weight scales in the industry. Whether you are a grower or distributor write us about your business.



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NEW BRUNSWICK, N. J.

POTATO BREEDING, GENETICS, AND CYTOLOGY: REVIEW OF LITERATURE OF INTEREST TO POTATO BREEDERS[1]

F. J. STEVENSON[2]

Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture, Washington, D. C.

The literature indicates a wealth of material, species, and varieties, available to the potato breeder. Excellent work is being done by the British in studying the classification and cytology of their South American potato collection, but no comparable work is being done in the United States, although there is great need for it.

Progress is shown in breeding for resistance to important virus and fungus diseases.

Since the golden nematode has become such a menace to potato growing in a section of Long Island, the possibility of producing varieties resistant or tolerant to its attacks has been discussed. It has been the general impression that all varieties and species tested were susceptible, but Ellenby's (*10*) article indicates that some species are far less susceptible than others. In some cases a species was classed as susceptible on the basis of a single cyst on its roots. Giant hills, or "bolters"

[1]Some of the material in this report, especially that concerning articles written in foreign languages, was taken from the abstracts published by the Imperial Bureau of Plant Genetics, Cambridge, England.

[2]Principal Geneticist.

as they are called in England, have been observed in the United States for many years. Thomas (*35*) stated that they are characterized by the presence of a small additional chromosome fragment.

The remarkable influence of stock on scion is shown by several Russian workers.

Blackening after cooking is a genetic character conditioned by genes but influenced by environment.

Much interest is being shown in ascorbic acid content. Factors that determine the amount of ascorbic acid in the finished food product include variety, seasonal and other environmental conditions, state of maturity, storage temperatures, and cooking methods.

A relatively large number of varieties have been described within the last three years.

Breeding Methods

Krantz (*22*) reported investigations on potato breeding based on what he considers the relationships between flowering, fruit development, and tuber production.

Breeding Program

Stevenson (*34*) gave a brief account of the early improvement of the potato in the United States, the work that is being carried on at present under the National Potato-Breeding Program, and some of the possibilities for the future.

Breeding Material

Hawkes (*16*) described the values to the breeder of some of the indigenous American potatoes.

Solanum demissum is valuable because of its resistance to blight, Colorado beetles, and frost, and because of its fertility when selfed and crossed with the tetraploids *S. andigenum* and *S. tuberosum*. *S. andigenum*, the most promising cultivated species, contributes high vigor, yield, protein, vitamin C, and starch content, together with a greater range of flavor and cooking qualities than that of the ordinary European domestic potato. It is highly fertile. In problems that have hardly been touched, such as resistance to nematodes, the need for a thorough survey of the indigenous American potatoes was emphasized.

Classification and Cytology

Hudson (*17*) reported that the classification and cytology of the South American potato collection was almost completed. *Solanum ajuscoense, S. antipovichii, S. calcense, S. garciae jamesii,* and many

samples among *S. andigenum* showed promise of resistance to virus diseases. Some clones were found resistant or immune to blight. Nearly 1,500 lines were tested for frost resistance, and 216 lines showed resistance. Some lines appeared to be immune or highly resistant to eelworm attack.

CYTOGENETICS

Lamm (*23*) reported the results of cytogenetic studies in a number of species of *Solanum* by means of cytological investigation, interspecific hybrids, and colchicine-induced polyploids. *Solanum curtilobum* (pentaploid) as maternal parent crosses readily with *S. tuberosum* and *S. andigenum;* the first-generation hybrids are comparatively fertile. The reciprocal cross is difficult to achieve but was obtained by grafting the maternal parent on tomato. First-generation hybrids of this cross are male-sterile.

Meiosis in the first cross is normal; in the reciprocal abnormal. Hybridization between *Solanum acaule* and *S. tuberosum* failed. After chromosome doubling in *S. acaule* hybrids were easily obtained, *S. acaule* being used as female parent. The first generations of the hexoploid and near hexaploid are fertile. In the case of the tetraploid species it is suggested that *S. tuberosum* is mainly an autotetraploid but in comparison with the true colchicine-induced autotetraploids investigated, shows differentiation in the direction of allotetraploidy. *S. acaule* and *S. tuberosum* appear to be related tetraploids.

GENETICS OF TUBER COLOR

Carson and Howard (*6*) stated that the variety King Edward is simplex for the gene K, determining pink periderm coloration, and is multiplex for gene K which induces pink cortical pigmentation. A converse arrangement was found for the variety Flourball.

GENETIC LEAF ROLL

LeClerg (*25*) reported a leaf roll of small potato seedlings grown from true seed in 3-inch pots in the greenhouse at Baton Rouge, Louisiana, during the winter of 1943. This was shown to be genetic since it occurred in some family lines and not in others. Stem-graft inoculations with the rolled plants on disease-free stocks all gave negative results, which indicated that the rolling was not due to virus. None of the plants grown in the field from tubers produced in the greenhouse showed any type of leaf rolling during the growing season.

VIRUS RESISTANCE

Feistritzer (*11*) gave a detailed description of the difficulties of breeding potatoes resistant to leaf roll; to viruses A, Z, and Y; or to

mixed infections. Since complete immunity to the severe degeneration diseases has not been found, the present aims of a breeding program should be discovering and producing types more resistant than the most resistant known varieties. Several selections from crosses of varieties whose resistance was recognized by growers, were found to be equal to the parent in resistance, and at least two of them were more resistant. The difficult problem of combining increased resistance with good table quality was brought out, since a large number of factors must be combined to ensure a combination of these two characters in a high degree.

Resistance to Virus Leaf Roll

Folsom and Stevenson (*12*) reported the results of a number of tests of seedlings and varieties for their reactions to field spread of leaf roll. These were grown adjacent to rows of leaf roll plants in an area where the disease spreads consistently year after year. At first, American varieties and European varieties reputed to be resistant to leaf roll were used as parents, and a few of the crosses contained some seedlings resistant to the natural spread of leaf roll. When these resistant seedlings were used as parents the resulting progeny showed more resistance. It is possible to combine field resistance to leaf roll with many characters of commercial importance.

McKay and Clinch (*26*) reported a high degree of resistance to leaf roll in Skerry Champion. It showed about 1 per cent infection while Matador and Shamrock showed 8 per cent.

Resistance to Virus Y

Badwin and Kassanis (*2*) reported that the American variety Katahdin showed the highest degree of resistance to virus Y among the varieties tested. Various degrees of resistance were found among the commercial English varieties. Relative susceptibility in field tests was found to be correlated with susceptibility when colonized with infective aphids. Susceptibility to virus Y and to leaf roll are independent.

Hutton and Bald (*19*) reported that in an attempt to breed hybrid potatoes resistant to virus Y the development of a necrotic reaction to the condition of hypersensitivity seems to be more promising than breeding for immunity. Hypersensitive seedlings were selected from the crosses Snowflake x Katahdin and Brown's River x Katahdin.

Hutton (*18*) reported further that once hypersensitive types have been selected in the hybrid progeny, crosses involving them produce 10 to 30 per cent of hypersensitive seedlings. As breeding sources of hypersensitivity the varieties Snowflake, Katahdin, and Brown's River have been found to be more promising than Bismark, Delaware, Factor, and

Sebago. The hypersensitive reaction to virus Y appears to depend on one or more recessive alleles, tolerance to the virus being dominant.

Severe Strains of Virus X

Fred (*13*) of the Wisconsin Agricultural Experiment Station reported work done by Larson from which he learned that severe strains of latent potato viruses commonly are associated with low-yielding lines of potatoes, whereas mild latent viruses generally are found in the higher-yielding potatoes.

Resistance to Late Blight

Black (*3*) reported on the inheritance of reaction to the common A strain of blight in a triple hybrid (*Solanum rybinii* x *S. demissum*) x *S. tuberosum* and from a multiple hybrid W 800 (*2*) in which five species, *S. commersonii*, *S. maglia*, *S. edinense*, *S. demissum*, and *S. tuberosum* were involved in the pedigree. The results suggest that the primary reaction of resistance and susceptibility to blight depends upon two major genes Ra and Rb, and that minor genes determine the degree of susceptibility in susceptible varieties and act as modifiers in resistant varieties. In general, the segregations of resistant and susceptible plants do not fit the ratios 1:1, 3:1, or 15:1, a consistent excess of recessives being shown.

Physiologic Races of Scab

Schaal (*33*) found that single-spore cultures of scab (*Actinomyces scabies*) obtained from potatoes grown on various soil types in different states differed in color of mycelium and of pigment produced on modified potato-dextrose agar. The isolates were unstable and produced variants that were often culturally different from the parents and from each other. A number of isolates tested on three commercial and five seedling varieties of potatoes different in pathogenicity. Certain strains produced russeting of normally smooth-skin varieties.

Wart Resistance

Hartman and Akeley (*15*) reported that the potato wart is still confined to restricted areas in Pennsylvania from which state it was first reported. Its spread has been controlled by temperature and moisture relationships, by immune varieties, and by strict quarantine regulations. So far there is no evidence of new biotypes in the United States, but there is no assurance that new forms having greater virulence and a wider range of adaptation will not be found. Of fourteen new American varieties Katahdin, Mohawk, Sequoia, Mesaba, and

Norkota are immune. Two selfed lines of Katahdin showed after grouping about fifty per cent of their seedlings to be very resistant to wart.

Verticillium Resistance

Mujica (*27*) established the existence of different races of *Verticillium albo-atrum*. Irish Cobbler was susceptible, and Katahdin proved immune.

Brown Spot

Fred (*13*) of the Wisconsin Agricultural Experiment Station reported work done by Larson the results of which indicated that the newest potato varieties, like standard ones, differ markedly in their susceptibility to what is variously known as internal brown spot or nonparasitic tuber necrosis. Least susceptible were Triumph, Pontiac, and Red Warba; intermediate, Chippewa, Sebago, Sequoia, Russet Burbank, and White Rose; most susceptible, Russet Rural, Rural New Yorker, Katahdin, and Green Mountain.

Resistance to Aphids

Adams (*1*) pointed out the desirability of breeding a commercially acceptable potato variety whose aphid resistance would be substantial enough to limit the spread of aphid-borne viruses in the crop. A considerable number of American and European varieties and a number of species were tested for their reactions to aphids. Two criteria were used in classifying the varieties: aphid population build-up and plant injury. The varieties were placed in five classes; very susceptible, susceptible, tolerant, resistant, and very resistant. Katahdin and U. S. D. A. Seedling 41956 were very susceptible showing peak population of 35,000 aphids. The plants of these two varieties were dead six weeks after the establishment of the aphid colonies. Chippewa, Irish Cobbler, Triumph, Sebago, and Pontiac were susceptible; Green Mountain, President, Warba, Arran Victory, and *Solanum chacoense* were tolerant; Fredericton Seedling 996-1-4, Houma, Earlaine, Sequoia, *S. demissum, S. commersonii,* and *S. chacoense* were very resistant; and *S. polyadenium* seemed to be immune. A similarity between results obtained in leafhopper resistance studies and those found in aphid studies is noted.

Nematode Resistance

Ellenby (*10*) tested a number of species and varieties from the Empire Potato Collection for their reaction to golden nematode. Nearly forty South American species showed susceptibility to eelworm attack when grown in soils infested with cysts. Most of the plants of the species tested appeared to be less susceptible than the *S. tuberosum* variety Great

Scott. Fewer cysts were formed and in some cases a species was classed as susceptible on the basis of a single cyst on its roots; in addition, the cysts were often more immature than the cysts on the roots of the control.

Mutations

Thomas (*35*) reported that "bolter" forms of the varieties Gladstone, Doon Star, and Majestic are characterized by the presence of a small additional chromosome fragment.

Grafts

Glushchenko (*14*) reported that by propagating from the adventitious buds on various potato varieties white or yellow progenies were obtained from colored parents. In the progeny of the variety Zarnica vegetative segregation occurred. Different tubers on the same plant showed different colors. Variations of a similar kind were observed in other characters. The existence of genetic differences in different plant tissues was given as the explanation.

Turlapova (*36*) described the development of an early industrial variety of potato by grafting. In 1939, 600 grafts were made of starchy varieties, such as Wohltmann and Korenevskii on the Early Rose. Of the grafts eighty-seven per cent were successful. The influence of stock on scion was observed in the flower color and in the form and color of the tubers. Three selections were made which exceeded the Early Rose in yield and starch content. The new hybrids were a few days later than Early Rose in maturity but the tubers reached the maximum starch content earlier than Early Rose.

Tushniakova (*37*) reported that a potato grafted on *Datura inermis* Jacq., for example, contained 0.3 per cent of atropine. It formed aerial tubers, and these when planted gave rise to plants that contained up to 0.15 per cent of atropine in their leaves, stems, and tubers. In 1942, among the progeny of Bison tomato grafted on potato, one plant was found that produced three small tubers on its roots; from them three abnormal potato plants were produced, which formed a mass of aerial tubers on their stems, together with a number of small underground tubers. Both aerial and underground tubers were planted and gave rise to the same type of plants as their parents.

Blackening after Cooking

Rieman *et al.* (*32*) found consistent differences in amounts of blackening after boiling among 23 potato varieties and strains grown over a period of five years at 9 widely separated locations in Wisconsin. The two whitest-cooking varieties, Triumph and Chippewa, showed

only one-half as much blackening as the two dark-cooking varieties, Rural New Yorker and Russet Rural. The white-cooking tendencies shown by the closely related Chippewa, Katahdin, and Sebago suggest that these carry genetic factors for white tuber flesh after boiling. Results from certain crosses indicated that white tuber flesh after cooking was dominant or incompletely dominant to gray tuber flesh. Parental types were readily recovered in the first generation, indicating simple factorial interactions and heterozygosis in the parental stocks.

Ascorbic Acid Content

Werner and Leverton (*38*) examined more than 5,000 tubers over a period of three years for ascorbic acid content. The ascorbic acid content differs with varieties. Growing conditions, stage of maturity at harvest time, and storage temperatures cause variability within the variety. Potatoes harvested at practically the same stage of maturity in three different years differed greatly in ascorbic acid content. Ascorbic acid seems to increase in the tubers until the vines reach maximum growth, and as the vines mature the ascorbic acid content of the tubers decreases. Potatoes grown on dry land generally have a greater amount of ascorbic acid than those grown under irrigation. Potatoes lose ascorbic acid at a relatively constant rate during storage but they lose the least when stored at temperatures between 50° and 70° F. Potatoes cooked carefully in very little water and tight-fitting kettle lids lose as little as five per cent of their ascorbic acid, but boiled vigorously in a large amount of water they may lose as high as twenty per cent or more.

Murphy (*28*) stated that when cabbage, collards, broccoli, kohlrabi, turnips, tomatoes, and potatoes were compared for vitamin C content potatoes ranked sixth, but when the same values are calculated according to appetite level the potato ranks first. Loss of vitamin C in storage is related to variety and temperature. Irish Cobbler, Green Mountain, Mohawk, Chippewa, Katahdin, and Sebago were held at temperatures of 32°, 36°, 50°, 60° or 65° and 70° F. for seven months in two successive seasons. Tubers were analyzed for vitamin C at monthly intervals. Mohawk showed a relatively high vitamin C content when freshly dug and remained at a relatively high level. Chippewa was low throughout the entire period. Sebago decreased at a disproportionately rapid rate, but Green Mountain tended to improve its position. In general, varietal differences diminished greatly under the influence of storage but were not completely nullified. If vitamin C retention is a criterion of quality 50° F. would be the best temperature tested.

Lampitt *et al.* (*24*) found that variety, soil, and storage affected

the vitamin C content of the potato. Samples were taken from four widely scattered areas in England and Scotland. Comparison between freshly dug and stored potatoes showed a steady decline in vitamin C content from 0.30 mg. per gm. at the end of August to 0.08 mg. per gm. in January. The vitamin C content of King Edward VII was consistently higher than that of the other varieties from August to December.

Karikka *et al.* (*21*) observed varietal differences in the ascorbic acid content of potatoes grown in different localities in New York State in three seasons. Katahdin and Houma gave high values in all three years: Chippewa tended to be low; Irish Cobbler, Warba, and Sebago were intermediate; and the results for Earlaine and Green Mountain were inconsistent. Ascorbic acid content of potatoes grown in different locations showed marked variation. The factors involved in this variability are not known. Neither soil reaction, nor amount of nitrogen, phosphorus, and potassium in the fertilizer, nor the addition of minor elements had a consistent influence on the ascorbic acid content of potatoes. Losses of ascorbic acid tended to occur more slowly in potatoes stored at 50° F. than in those stored at 40°. Approximately two-thirds of the ascorbic acid content of the raw tuber remained in the boiled potato.

Florida Variety Tests

Eddins *et al.* (*8*) reported some of the results of potato variety tests at Hastings, Florida. Sebago, Sequoia, and Pontiac, which proved to be more resistant to freezing injury in the early stages of growth and more drought resistant than eleven other varieties, produced the best yields for seven years. Sebago and Pontiac yielded about one-third more U. S. No. 1 tubers per acre than Katahdin, whereas Sequoia exceeded the yield of the latter by approximately fifty per cent. Sebago and Katahdin have supplanted almost completely the old standard variety Spaulding Rose.

New Varieties

Blodgett and Stevenson (*4*) described three new scab-resistant varieties Ontario, Seneca, and Cayuga. Ontario gave the highest yields of the three. It is highly scab-resistant and also has some resistance to late blight and fusarium wilt. It has fair cooking quality but is not so high in specific gravity as Cayuga. The latter was comparable in yield to Rural and Sebago. Like Ontario, it is highly scab-resistant and has some resistance to late blight and fusarium wilt. It has high specific gravity, cooks white and mealy, and remains white after cooking. Seneca is intermediate in ripening between Cayuga and Ontario. It

has some resistance to late blight and wilt but is not so resistant to wilt as Ontario.

Riedl *et al.* (*31*) described the Teton potato, a new variety resistant to ring rot. This variety has shown a high degree of resistance to ring rot over a period of years in Wyoming and Maine. It produced satisfactory yields and cooking quality in tests in both states. It is not immune to ring rot but should be valuable in districts where ring rot is a serious menace to potato production.

Clark (*7*) described the Calrose potato, a new variety possessing resistance to late blight. It is a high-yielding variety that has proved to be well adapted to environmental conditions in California. It produces an abundant set of tubers that are long, smooth, and attractive in appearance. It requires a relatively long period of growth, which should enable it to supplement other varieties in extending the length of the harvesting and marketing periods where this would be desirable.

Edmundson *et al.* (*9*) described the Pawnee potato. It was a selection from a cross between Rural New Yorker No. 2 and Katahdin and is believed to be a valuable medium-early variety for certain districts.

Bushnell *et al.* (*5*) described the Erie as a new high-yielding variety adapted to conditions in Ohio.

Jehle and Stevenson (*20*) described the Potomac variety whose parentage is Rural New Yorker x Katahdin. It possesses good baking quality and has moderate vine and tuber resistance to late blight, and to injury by flea beetles and leafhoppers.

Wheeler *et al.* (*39*) described the Menominee potato, a new variety resistant to common scab and late blight. It is a selection from a cross of Richter's Jubel and seedling 44537. Menominee is highly resistant to scab and moderately resistant to late blight. If planted early in Michigan it produces high yields of tubers having good cooking quality. It is scab-resistant in Maine where it was first produced and tested but has not been promising except for its scab resistance.

Reddick and Peterson (*30*) described the Empire, a blight-resistant variety. This variety was produced as the result of a series of crosses made for the purpose of producing new commercial varieties which could combine the immunity to blight of the species *Solanum demissum*, Lindley with the desirable horticultural and culinary characteristics of the commercial varieties commonly grown in northeastern United States.

Empire is adapted to most parts of New York, but it is too late in maturity to be at its best on Long Island. It withstood severe inoculation tests in the greenhouse but was found not to be absolutely immune in the field. The authors assume that the resistance of Empire ultimately may break down and that the same assumption will have

to be made in the case of any introduction of a blight-proof potato until long experience indicates that a breakdown does not occur.

It is stated in THE POTATO WORLD dated January 1, 1946, that Dr. Donald Reddick of the New York (Cornell) Agricultural Experiment Station had named five blight-resistant varieties Ashworth, Chenango, Essex, Placid, and Virgil.

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NET RETURNS FROM POTATO FERTILIZERS

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Before a successful business man comes to a decision about an enterprise under consideration, he invariably wants to know two things —the cost of the investment and the probable gross returns. Given these, he can usually estimate his expected net returns or margin of

[1]Division of Fruits and Vegetable Crops and Diseases.

profit. That is one of the principal reasons he is a successful business man. It is not necessary to remind potato growers that they are business men but it does seem timely to extend a word of caution lest they forget momentarily that the only correct way to figure the relative profit between different rates of fertilizer application is from the returns "beyond" the cost of the fertilizer. It is understood, of course, that from these returns "beyond" the cost of fertilizer there must be deducted all other costs of production in order to arrive at the real net profits per acre, but we are not specifically concerned with these here.

Profits Based on Net Returns

Now this may appear to be a very elementary statement obvious to every one intelligent enough to grow potatoes, but under the stress of the period of unlimited production and guaranteed price from which we are at present emerging, this fundamental point in production economy can easily be overlooked. Furthermore, there are two misconceptions that I wish to discuss which help to make it easy for us to overlook it. For instance, those advocating the plowing under of large amounts of fertilizer in addition to the amounts applied at planting time, frequently compare the results obtained on the basis of gross returns without giving due consideration to the cost of the additional fertilizer plowed under. This, of course, is an error. Whether this charge for fertilizer should be made against the first crop or spread over succeeding crops is a question that can only be answered by experiments conducted on the same land for a period of years, but one thing is certain, it should be charged against some crop or crops.

Law of Diminishing Returns

Another misconception, and this one can be very serious for some potato growers, stems from statements such as these: "For every dollar spent for fertilizer there is a gross return of $3.60" (2), or as recently reported from one southern potato-growing state, $1.50 to $9.00 (1). These statements can be misleading in two ways. In the first place, they imply that the gross returns from fertilizer use is linear, that is, if these returns are plotted they will form a straight line, as illustrated by the dotted line A in figure 1. Actually, however, these returns do not form a straight line, but a curved line as shown in the illustration. This particular curved line represents the estimated gross returns based on 7-year average yields of No. 1 potatoes[2] from fertilizer rate experiments conducted on the North Shore of Long Island and with the growers' own fertilizer, which at that

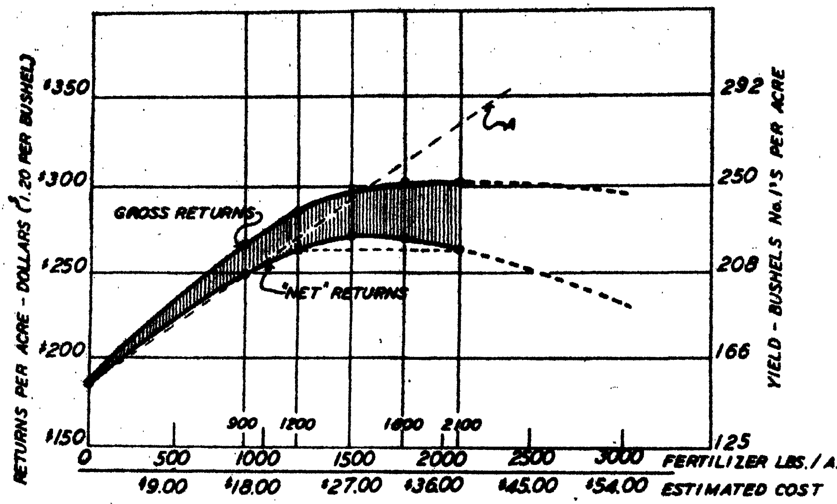

FIGURE 1. Curves showing gross returns, and net returns per acre "beyond" the cost of potato fertilizer applied at different rates per acre. A: theoretical linear relationship $1.00 for fertilizer (Long Island data) produces $4.06 average gross returns.

time was a 4-8-5 mixture. The only part of this curve that would approach the theoretical straight line implied by the foregoing statements obviously corresponds to rates of application too low for the economic production of potatoes on Long Island.

You may be wondering why the true relationship between fertilizer use and the returns therefrom is described by a curved line and not a straight one. There are two reasons: In the first place, the productiveness of land is not unlimited. It is true, of course, that the maximum production can vary from farm to farm and even from field to field with the kind of land, the manner of treatment, the weather conditions, and the ability of the grower, but strive as you may, under any given set of conditions, there will always be a limit to the productive capacity of any land. For these reasons a "net" returns curve should be obtained from every farm or field, if possible.[3]

The upper yield or gross returns curve in figure 1 illustrates what the writer has chosen to call "The Law of Diminishing Need." The principle that makes this *biological law* operative is widespread in

[2]These yields were obtained by Dr. Bailey E. Brown, formerly Senior Biochemist, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture.

[3]The writer has prepared a set of instructions which describe in detail a method for conducting a simple fertilizer rate test on potatoes, the results of which can be used to plot a "net" returns curve. If you are interested write to him for a copy.

its application and is familiar to nearly every chemist and undoubtedly is recognized by many agronomists as well. It operates with increasing applications of single elements, such as nitrogen, phosphorus, and potash, as well as with complete fertilizers. This being true, the second reason follows inevitably, illustrated by the second curve,—under these conditions the *physical law* of diminishing returns, as illustrated by the "net" returns curve, is bound to operate. These are two laws that will never be repealed despite the tacit assumption of those who imply the straight line relationship illustrated in figure 1.

The Fallacy of Gross Returns

As business men and potato growers, however, your real interest lies not so much in gross returns as in net returns, in this particular case, returns "beyond" the cost of fertilizer. To illustrate the relationship that can be expected between gross returns and net returns a curve has been drawn indicating the returns "beyond" the cost of fertilizer with the selling price of potatoes estimated at $1.20 per bushel and the cost of fertilizer at $36.00 per ton. Obviously, these prices are estimates, but they will serve the present purpose. If they are altered either way, only the positions of the two curves will be mainly affected; there will be little effect on their shape. The important thing to notice about these two curves is the steadily increasing size of the shaded area between them, which represents the difference between gross returns and net returns "beyond" the cost of fertilizer. or its actual cost.

As will often be the case, the maximum net returns from fertilizer use will not necessarily come at the point of highest gross returns. After the point of highest net returns "beyond" the cost of fertilizer has been reached, which, for the fields under consideration correspond from 1500 to 1800 pounds per acre, the decline is steady even though the gross returns may have slightly increased. But it should be noted further, and this is important, that neither gross returns nor net returns follow a straight line for current Long Island applications as might be inferred from statements that each dollar spent for fertilizer will yield a gross return of a stipulated amount.

The Switch from Unlimited to Limited Production

These economic considerations, as simple as they may seem, are not always fully recognized during a period of unlimited production and guaranteed price. During a period of limited production, however,

with production quotas based on acres, as reflected by the goal requirements of the 1947 potato price support program, emphasis must be switched from quantity production to economic production.

About the only feasible way to limit total production while maintaining the maximum economic yield is to limit acreage. In this way, there is a maximum return above the cost of fertilizer, the land is used economically, and some land is released for other cash crops or preferably for soil-building crops. In this regard, it will be of interest to note from figure 1 that the particular fields studied showed just as large a net return from 1200 pounds of fertilizer as from 2100 pounds and 5.5 per cent fewer potatoes to handle.

The foregoing economic discussion of fertilizer use could be summed up in the statement sometimes made by potato growers (usually over 50 years old) who declare that they are not growing their crop as well as they know how because they couldn't afford to. In this statement, usually intended for a joke, there is a good deal of economic wisdom, provided they are sure that they have reached the point of maximum net returns on their farms.

From the study of curves similar to the one presented, which would show the net returns "beyond" the cost of fertilizer for any particular field or farm, much information can be obtained which will help to make a good potato grower a successful business man. To illustrate, the 7-year average yields used in the present discussion were obtained without irrigation. It would be of interest and of considerable value to obtain a similar curve while using irrigation and larger amounts of fertilizer than customary. In this way it would be possible to evaluate the efficiency and economy of both fertilizer and irrigation in a way that would have real meaning to a potato grower—his net returns per acre.

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TIME OF INFECTION AND ACCUMULATIVE EFFECT OF RHIZOCTONIA ON SUCCESSIVE CROPS OF POTATOES[1]

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INTRODUCTION

Rhizoctonia disease of potatoes is caused by *Rhizoctonia solani* Kuhn (*Corticium vagum* Bourd. and Galz.) and it infects potato plants either through soil-borne mycelium or through mycelium produced from sclerotia present in the soil or on the potato tubers. Practically all underground parts of potato plants are subject to infection with *Rhizoctonia,* especially the underground stems, stolons, and tubers, and to some extent potato roots.

Potatoes are usually planted in Montana some time in May and the heaviest rainfall ordinarily occurs in June, when temperatures are also quite low. During this period of unfavorable weather conditions potato plants grow slowly and they are usually quite susceptible to attack by *Rhizoctonia.* Consequently, in certain years *Rhizoctonia* causes a considerable amount of damage to the potato crop in Montana. Most of the commercial growers in Montana treat their seed potatoes either with mercuric chloride or formaldehyde, so the danger of introducing infection in the soil with the tubers is rather slight. Severe outbreaks of this disease which often occur even in fields planted with treated potatoes, indicate that soil-borne *Rhizoctonia* probably is a great factor in the occurrence of this disease in the field.

The purpose of this investigation was to determine on land, not previously cropped to potatoes, the time and degree of infection with soil-borne *Rhizoctonia* of all underground parts of potato plants under conditions of continuous cultivation. The accumulative effect of inoculum in this soil on the severity of the disease in subsequent years was also investigated.

MATERIALS AND METHODS

Bliss Triumph potatoes were planted during the years 1936-1940 in the same ⅛ of an acre plot at the Huntley Branch Station, Huntley, Montana. The soil of this plot was of a clay-loam type with a

[1]Contribution from Montana State College, Agricultural Experiment Station Paper No. 193 Journal Series.

pH 7.8. No potatoes had been grown in this soil for at least twenty-five years. Preceding crops beginning with 1930 and ending with 1935 were as follows: sweet clover, corn, sugar beets, wheat (sweet clover), sweet clover, and corn. Moisture was supplied by irrigation, so during the growing season the soil always had a sufficient amount of moisture.

Certified potatoes practically free from infection with *Rhizoctonia* were planted. These potatoes were treated with formaldehyde, cut, and planted with a single row picker planter in rows three feet apart. Potatoes were usually planted some time in May and harvested during the latter part of September.

Examination of all underground parts of potato plants for infection with *Rhizoctonia* was made several times during the growing season and in addition the potato tubers were examined after harvest.

Potato stems, stolons, and roots were examined for *Rhizoctonia* lesions, and tubers for the presence of sclerotia. In 1937 four examinations of potato plants were made during the growing season and in the remaining years only three. At each examination, 30 potato hills

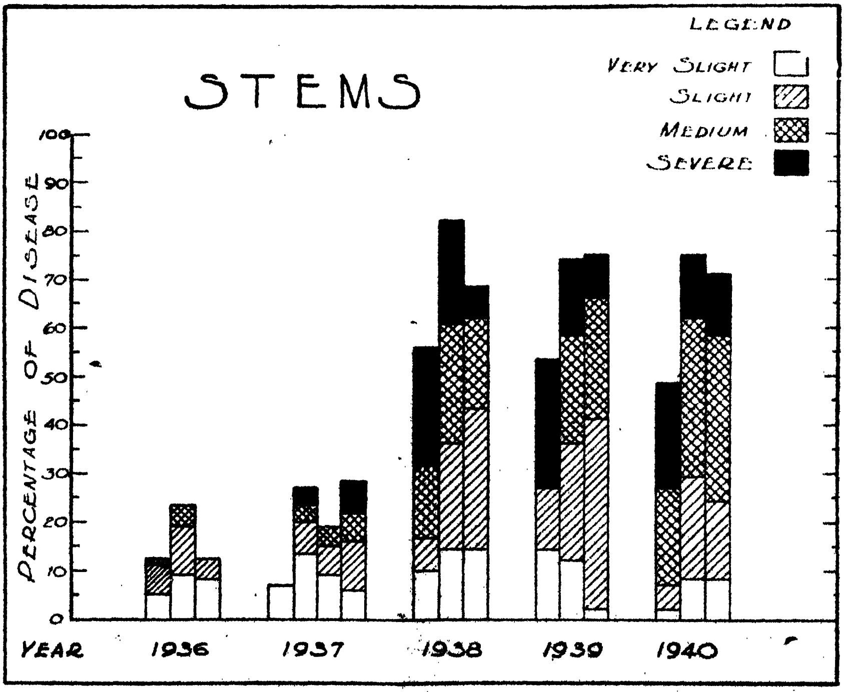

FIGURE I. Percentage of infection of potato stems with Rhizoctonia during 1936 to 1940.

were dug, and the underground parts of the potato plants were washed and carefully examined for the amount of infection with *Rhizoctonia.* In the fall at harvest time, a random sample of 100 pounds of potatoes was collected in this plot and graded for the presence of sclerotia on the tubers. The degree of infection of the different parts of potato plants with *Rhizoctonia* was recorded as: very slight, slight, medium, and severe.

Results

Potato Stems

The percentage of infection of underground parts of potato stems with *Rhizoctonia* was rather low (Figure 1) in 1936 and 1937 (maximum of 23.0 and 28.0 per cent respectively) and high in the remaining years (maximum of 82.0, 75.0, and 75.0 per cent respectively for 1938, 1939, and 1940). The amount of infection of potato stems in all years was usually the lowest on the first date of reading. The second reading in most of the year (1936, 1938, and 1940) showed a somewhat greater infection of stems with *Rhizoctonia* than the last one. This situation probably was due to the fact that the plants which

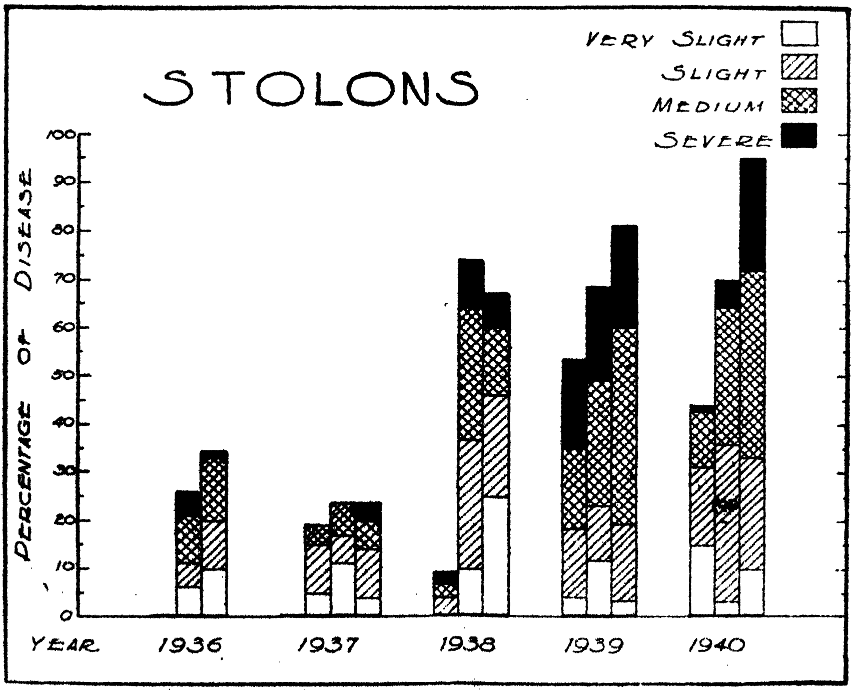

FIGURE 2. Percentage of infection of potato stolons with Rhizoctonia during 1936 to 1940.

were already severely infected with *Rhizoctonia* on the second reading perished before the last reading was taken. The proportional degree of infection, in general, was rather slight in 1936 and 1937, but in remaining years it increased considerably in its intensity. It appears that after two years of growing potatoes in this plot, the amount of infection of potato stems with *Rhizoctonia* reached its maximum and remained at about the same level during the last three years of this experiment.

Potato Stolons

The percentage of infection of potato stolons (Figure 2) with *Rhizoctonia* showed about the same trend as that of the stems. In the

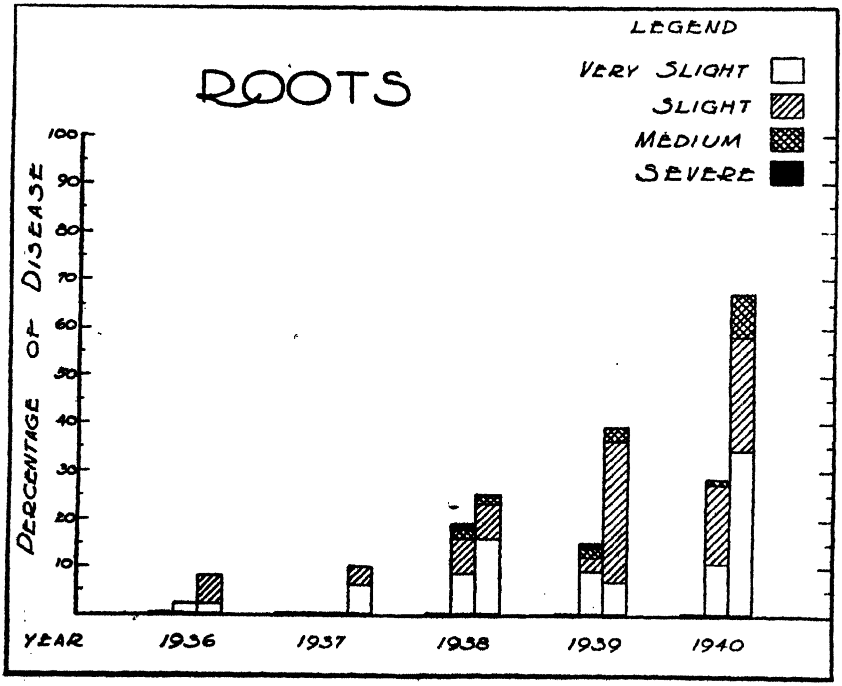

Figure 3. Percentage of infection of potato roots with Rhizoctonia during 1936 to 1940.

years of 1936 and 1937 the stolons had the lowest percentage of infection (maximum of 34.0 and 23.0 per cent respectively), but in the years 1938-1940 infection began to increase rapidly and in 1940 most of the potato stolons (95.0 per cent) showed infection. The lowest infection of potato stolons in all years was on the first date of reading and the highest, with the exception of 1938, on the last date of read-

ing. The proportional degree of infection of potato stolons with *Rhizoctonia* gradually increased toward the end of the experiment.

In general, these results show that the greatest increase in total infection of potato stolons with *Rhizoctonia* occurred in the third year of the experiment, after which infection also continued to increase, although only at a low rate, until the end of this experiment.

Potato Roots

The percentage of infection of potato roots with *Rhizoctonia* (Figure 3) was low in 1936 and 1937 (maximum of 8.0 and 10.0 per

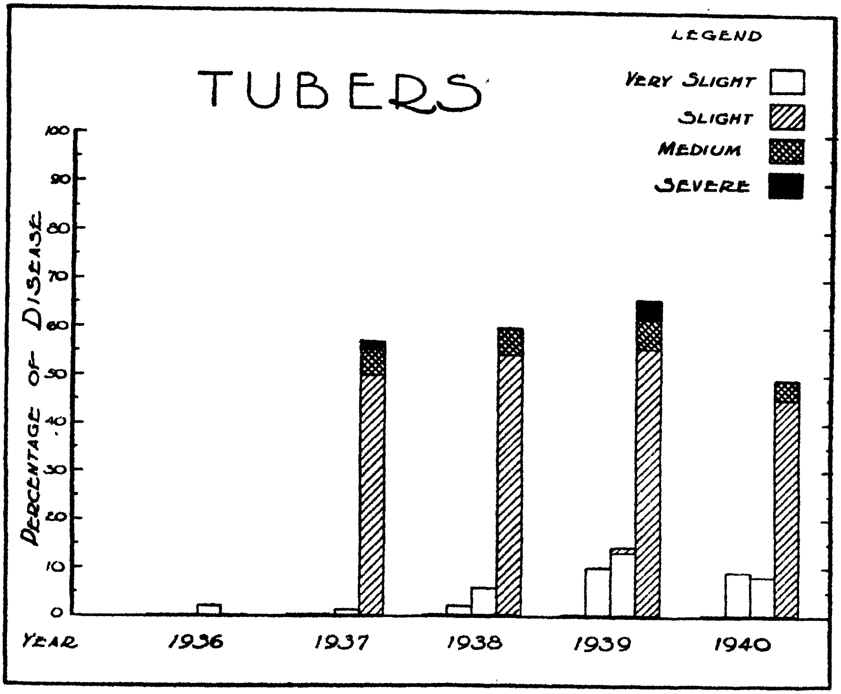

FIGURE 4. Percentage of infecton of potato tubers with Rhizoctonia during 1936 to 1940.

cent respectively). Beginning with 1938 the infection began to show a marked increase and reached 67.0 per cent of the total potato roots in 1940. Roots were usually free from infection on the first date of reading and the infection usually increased toward the fall. Infection of potato roots with *Rhizoctonia* was slight throughout all five years of the study, although its intensity was somewhat greater during the last two years of the experiment.

In general, these results show that infection of potato roots with *Rhizoctonia* continued gradually to increase during all five years of

the experiment and that the greatest relative increase occurred after the first two years.

POTATO TUBERS

In the first year of the experiment, the infection of potato tubers with sclerotia of *Rhizoctonia* was only two per cent (Figure 4). Potato tubers in all the remaining years showed a rather high and uniform infection with sclerotia, with the maximum of 66.0 per cent of infected tubers in 1939. The infection of tubers with sclerotia remained low during the growing period and greatly increased just before digging time. The degree of infection of potato tubers with sclerotia in all these years remained mainly slight in nature.

In general, these results show that the greatest increase in infection of potato tubers with *Rhizoctonia* occurred in the second year of the experiment. After this the percentage and severity of infection remained about the same for all remaining years of the experiment. The amount of infection of potato tubers in 1940 was even somewhat lower than in the three preceding years.

DISCUSSION

Potatoes had not been grown in the experimental plot for 25 years preceding 1936 when this investigation was started. Our records indicate that it is quite possible that potatoes had never been grown in this soil. During the period of 25 years prior to this experiment wheat, sweet clover, corn, and sugar beets were grown in this soil.

Apparently there were only very small amounts of soil-borne *Rhizoctonia* present in this soil at the time the first crop of potatoes was planted in 1936. At least during the first two years potato stems, stolons, and roots showed only a small percentage of infection, which considerably increased during the third and including the fifth year of the experiment. A similar increase in infection of tubers also occurred during the second year.

These results show that a sufficient amount of soil-borne *Rhizoctonia* was present in this soil even without cropping it to potatoes to be able to start initial infection. It is also apparent that it takes only 1 or 2 years for the *Rhizoctonia* disease to increase in the soil to become an economic factor in the growing of potatoes. These results emphasize the importance of soil-borne *Rhizoctonia* in producing infection on potato plants planted with disinfected tubers.

In evaluating the susceptibility of different parts of potato plants toward infection with *Rhizoctonia*, it appears that potato tubers are very susceptible to this fungus. The tubers showed infection only with

sclerotia, and this infection appeared in considerable amount only immediately preceding the harvest. The stems and stolons appear to be equally susceptible to this fungus and more so than the roots, which showed considerable resistance to infection with *Rhizoctonia*.

In controlling this disease, cultural practices such as planting crops resistant to *Rhizoctonia* and growing potatoes only once in several years will prevent the accumulation of *Rhizoctonia* in the soil. Potato tubers which are used for planting should be disinfected to prevent introduction of new inoculum in the soil.

Summary

1. Treated potato tubers were planted in five successive years in soil where potatoes apparently never were grown before, to study the infection of potato plants with *Rhizoctonia*.
2. Potato tubers had only a very small percentage of infection with *Rhizoctonia* in the first year and this infection increased considerably the second year and remained until the end of this investigation.
3. Potato stems, stolons, and roots showed a small percentage of infection during the first two years and this infection increased considerably for stems and stolons and moderately for roots during the third year of the study and remained at the same level until the end of the investigation.
4. Potato stems, stolons, and tubers are very susceptible and potato roots are somewhat resistant to infection with *Rhizoctonia*.
5. It appears that a period of only one or two years is necessary under favorable conditions to build up the *Rhizoctonia* inoculum in the soil to produce maximum infection on potatoes.
6. In controlling this disease it appears it is necessary besides treating tubers, to use long rotations.

SECTIONAL NOTES

ALABAMA

Alabama has an increased allotment for Irish potatoes under the 1948 support program. Present indications seem to point to a reduction rather than an increase in planting. A good estimate, at this time, would be about 15,000 acres for our early Commercial section or approximately 2,000 acres less will be planted during the season of 1948. As the deal gets started interest will naturally increase and additional acres may be planted. Our ratio of Triumphs and Sebago will be nearly the same as last year,—⅔ Triumphs and ⅓ Sebago. The Triumphs will be produced for early shipment and the Sebago for later shipments.

This will be an expensive crop to plant, probably the most expensive in the history of our deal. Seed will sell at or near the $5.00 per hundred mark. Fertilizer has also increased in price. It will cost our growers more than $100.00 per acre by the time the crop emerges.

Most of the growers are preparing to control Late Blight with dust and there will be considerable spraying with Dithane. There seems to be plenty of material on hand to take care of this problem when it does arise. (Jan. 5).—FRANK E. GARRETT.

COLORADO

Shipments from Colorado have remained light this past week. However, the demand is reported to have shown some slight improvement. The San Luis Valley has shipped to date about 5,500 carloads, which leaves a balance of about 3,000 carloads to be shipped from that area.

Some seed shipments are beginning to move both into the state and out of state. Seed shipments or re-certification have come into the state from Prince Edward Islands and North Dakota. Out-of-state shipments have been largely to Texas and Arizona, to be planted for the early market.

The winter test plantings in both Texas and California have now been completed. Disease readings will be made about the 15th of February. In addition to winter testing in a southern climate, considerable hill and unit indexing is being done in the green house as an aid to foundation growers.

That part of the Western Region Hope-Flanagan Marketing Research studies which are being undertaken by Colorado are getting under way this week in Denver. These pilot studies may extend into other markets next year. At the present time these studies are to determine consumer preferences in regard to size and type of package. Special types of packages containing sizes 2" to 2½" and 2½" to 3" are being followed through from the packing house to the consumer in retail stores. (Jan. 6).—CECIL W. FRUTCHEY.

FLORIDA

Climatic conditions during December were generally favorable for potatoes in the Homestead area, although wet fields continued to retard planting operations on some farms until the week of the 15th of January. A total of approximately 5,500 acres were planted over a period of 75 days. The crop now growing looks well with prospects of good yields in all fields that were planted during November. These plantings escaped much seed-piece decay.

Some late blight is present in all fields but growers have held it

under control by spraying to the present time. Serpentine leaf miners are less in evidence than was the case last year. (Jan. 10).—G. D. RUEHLE.

MAINE

The Executive Committee of the Aroostook County Farm Bureau in behalf of Maine farmers has requested the Commissioner of Agriculture to institute proceedings that would bring about hearings on a Marketing Agreement. This decision was reached as a result of twenty-eight Triple A meetings in Aroostook County which were attended by 1,632 farmers. The farmers were virtually unanimous that a Marketing Agreement should be considered.

The market continues to hold rather closely to the support price, although there is some optimism concerning the spring market. The government has purchased 4,810 cars of the 17,962 cars shipped to the 7th of January. This indicates that the department has been a big factor in supporting the price.

Several sections of the county have experienced a great deal of field frost in some of their potato stocks. Many of them show frosted ends which is a big headache to some shippers. It is thought that these potatoes have now been fairly well moved from the county.

A campaign to have every farmer plant certified seed is being conducted. The estimate for the Maine crop in 1947 indicates 345 bushels per acre. The average for all varieties for certified seed is 391 bushels to the acre. The difference of 46 bushels gives the campaign some real arguments for every farmer to plant certified seed. If this campaign goes over well it should do much to eliminate ring rot from the county.

Stem-end browning is appearing in a number of varieties. At first many felt that it might be a discoloration caused by killing tops with various materials but a number of lots have been noted which died naturally, so it is apparent that stem-end browning cannot be blamed upon top killing materials.

Aroostook farmers are still interested in continuing price support and members of the Triple A recently indicated that they would be willing to accept another 5 per cent reduction in acreage if all the country would do the same. (Jan. 8).—VERNE C. BEVERLEY.

NEW JERSEY

The Government's plan to cut the New Jersey potato acreage approximately 20 per cent in 1948 has been abandoned according to advice from the P&MA. This is good news to our potato producers since such a cut in many instances would have reduced the individual grower's

acreage to such a point that it would not be economically sound to continue to raise potatoes. Such a request would have forced many growers to disregard government requests and plant in excess of their goals.

The Potato Industry Committee has voted to inform the State P&MA that (1) many growers would voluntarily reduce their acreage in 1948 and leave this acreage in wheat or other crops if the P&MA would guarantee that such a reduction would not be taken into consideration in setting any future goals or acreage allotments. The world is in great need of additional wheat and this action would add materially to the supply.

(2) New Jersey growers are also in favor of the plan abandoned by P&MA last year whereby if the Government had to purchase potatoes to support the price, that such purchases would be made at market prices below the 90 per cent of parity price and that the difference between the purchase price of 90 per cent of parity be paid to the producer. The market price however, would not be allowed to drop below a definite flow price. This plan would reduce the price of potatoes to the consumer in case of an over-supply in the markets at any time which would require the government to support prices.

(3) The brokerage of 8 cents a sack allowed for selling potatoes to the Government is too high and gives the dealer no incentive to try to sell his potatoes to the trade and should be reduced to 5 cents.

The Annual Meeting of the New Jersey State Potato Association was in Trenton January 29 and 30, during Farmers' Week. Many important topics were discussed, including the future of the industry, and government support, the status of the Golden Nematode, marketing, wireworm control, spray and dust materials, and general cultural topics. (Jan. 17).—J. C. CAMPBELL.

NEW YORK

Since the 1st of January, growers have responded to the increase in Government support price much better than they did in December. Most generally in up-state New York they are at support levels.

There is beginning to be a lot of interest in seed potatoes for spring shipment. Growers have apparently completed and planned for the 1948 season and it would appear that they expect to plant about the same as last year.

There is very little interest in preparing for Post-Stegall among some large growers. There seems to be a feeling for regulations of acreage with support price coupled with some form of marketing agreement. Perhaps the majority of growers are not in favor of any program.

More than a thousand potato growers attended the Annual meeting

of the Empire State Potato Club in Syracuse on the 8th and 9th of January, and many problems of practical nature were discussed. Features of the Convention were sessioned with potato specialists at the College exhibit, big Trade Shows, and forum discussions on current subjects of interest to potato growers were held. (Jan. 7).—H. J. EVANS.

TEXAS

The spring crop of potatoes in the Rio Grande Valley will be about two weeks earlier than normal. Rains came the early part of December and provided sufficient moisture for planting. Rain always provides more perfect moisture than irrigation, so our stands should be better than normal. We have estimated that the acreage to be planted in this section for spring harvest will be 11,500 acres. (Jan. 9).—CLEVE H. TANDY.

PROVINCE OF ONTARIO

Two hundred and seventy-five potato growers in Ontario have completed their activities in sixteen 500-bushel Potato Clubs, organized by various county and district branches of the Ontario Crop Improvement Association in 1947. The average yield for all these competitors, as uniformly calculated after carefully taken measurements and weights, is 392 bushels per acre, which is 14 bushels below last year's provincial average.

In the sixteen competitions, 123 competitors produced yields of more than 400 bushels per acre; 41 reached and passed the objective of 500 bushels; twelve exceeded 600 bushels and one grower broke previous records with his estimated yield of 718 bushels per acre.

Several clubs featured quality per acre and substantial prizes were also awarded for bushel exhibits and the condition of potatoes in storage. Potato growers banquets were held in eleven rural centres, where outstanding speakers were heard, presentation of prizes made and entertainment provided. Every grower whose yield was 500 bushels or more per acre received a certificate of merit from the Ontario Crop Improvement Association.

At a recent meeting of the Potato Committee, Ontario Crop Improvement Association, a decision was made to hold a full day's Provincial potato growers meeting at Toronto on Monday, the 9th of February. Arrangements were also made to hold a potato grower's luncheon on the same day. The program plans include several outstanding speakers and discussion periods on timely topics of interest to potato growers.

The committee heard reports on activities during the past season on the following topics: Spray and dust tests in Eastern and Western On-

tario; bacterial ring rot survey; 500 bushel clubs in Ontario; costs of production; grades and enforcement of grading regulations; storage holdings; market prospects and exhibition results. There was further discussion relative to the establishment of seed producing areas, testing and licensing of varieties and other subjects of importance to the potato industry.

Members of the Committee are: Howard Harper, Goodwood, *Chairman;* J. Nicol Wilson, Alliston; Hill Simpson, Bellwood; Edgar Hewitt, Simcoe; Ross Gregory, Strathroy; Lloyd Logan, Kemptville; Charles McQuire, Colborne; E. G. Snyder, Preston; George Hackett, Cochrane; A. V. Mason, Dundas, with R. E. Goodin, Toronto as secretary. (Jan. 2).—R. E. GOODIN.

NEWS ITEMS

C. L. FITCH

I. *The "Clean" Cobbler Supply of North America*

Third survey at five-year intervals

In 1937, I visited Prince Edward Island. That year Mr. Peppin had 1,800 of their little farms, with Cobbler fields which had had no visible virus found in them from 5 to 20 years or more, according to his certification inspectors; and there were a few such farms in other provinces of Canada.

In 1942, there were only 5 such farms on Prince Edward Island. The wish to get into the Katahdin, Chippewa, and Sebago seed trade had coincided with a sizeable peach aphid epidemic!

In September of this year, I was in Prince Edward Island, again. Many of Mr. Peppin's Cobbler growers had quit the leaf-roll carriers, D D T had come into the picture, and he had again 342 farms with clean Cobblers. As we complete this survey, we may find other such farms in Canada and a few in U. S. A. besides those mentioned below.

In the Lake-of-the-Woods and the Iron Range areas of Minnesota, and in S. W. Colorado, there were at least 10 to 40 farms where Cobblers have been clean for a score of years. Some clean Green Mountains have also been produced on these farms.

We thoroughly believe in the tuber unit and seed plot method for maintaining health and getting along with the stocks that are available; but we regard the purchase of "clean" seed as a superior part of an effective system wherever and whenever such seed is available.

Presented at the Annual Meeting of the Potato Association of America, Chicago, Dec. 28, 1947.

II. *A Case Appearing to be Stem Scald of Potatoes*

Veril Baldwin of Jackson, Michigan, in 1947, had a large field of Katahdins and Chippewas, in which 1 row of each sprayer width received no bordeaux. This resulted, by the 1st of August, in a serious dropping of leaves caused by late blight.

Immediately thereafter came the intense heat and drought of August 1947. The potato vines fell over and the tips assumed perpendicular positions. On many plants a large percentage of the recumbent part, a few inches from emergence from the ground, where facing the afternoon sun, were found a few weeks later to be rotted off up to the erect and partly shaded portions. The stubs of the stems were perfectly sound. On and in them, there was no sign of fungous or bacterial activity. The erect and partly leaved portion of the stems remained green after the stem below appeared completely decayed. Either conductive tissues had persisted, or the tips drew upon the wet and rotted stems as from a vase, or both.

A number of plant pathologists, from several departments, reported they had never seen this phenomenon. The growers in Indiana were the only ones who had seen it. I had never seen it and many specialists may never observe it. A college representative from East Lansing declared the trouble to be sunscald of stems. We are inclined to believe his opinion to be correct.

In our studies of frost injury, we proved that potato stems act as important conductors of ground warmth. In this case the cool ground apparently protected the stems from scald.

The yield of that field was considerably reduced. The losses from this trouble may never justify research studies of the matter.

III. *Plans for Large Expansion of Potato Breeding*

The National Potato and Onion Committee was formed 19 years ago, following a request from William Stuart, for the purpose of obtaining large appropriations for potato breeding. It has been my privilege to be the executive officer of that committee. It has functioned frequently, as needed, and several members at a time have appeared before appropriations committees at Washington. This committee held its first regular meeting at Mason City, Iowa, on the 9th of December. Nineteen members from 15 states were present. Dr. Henry A. Jones came from Washington for the meeting. The breeders from all nearby states were invited, but the invitations went through too many hands and therefore were too late so that only the Wisconsin and the Iowa stations sent representatives. They reported, barring salaries, that field trials are the largest expense of potato breeding.

So far about $1,000,000 of federal money and $2,000,000 of state money have been spent for these great projects. Onion breeding has already paid large commercial profits, and will soon make vast profits above the cost of the double project. Potato breeding to date has achieved no main commercial objective. It seems desirable to increase to a greater extent the potato seedlings produced by the states; and to uphold further the hands of our successful breeders of onions. This winter the committee desires to increase these federal appropriations from $65,000 per year to $125,000. Discussions are under way for a plan that may succeed not only with congress this winter, but also in the production of 3 to 5 times as many seedlings. This plan may take the form of the federal government bearing all field costs for all approved agencies.

"SOME OBSERVATIONS ON POTATO PRODUCTION IN CUBA"

Dr. Manuel A. Tamargo[1]

Ministry of Agriculture, Havana, Cuba

For many years Cuba has been importing certified seed from abroad for planting. Years ago, a few growers used hôme grown seed (small sizes) from the last spring crop for planting in early September. When the weather is favorable, planting starts about the middle of September. Immature seed has been troubling the growers for this planting, in the form of seed piece decay. Seed that has not completed the rest period is planted and irrigation water and rain often rot these seed pieces before the plants emerge from the ground. The best recommendation that can be given to the Cuban growers is, not to plant so early and, if necessary, plant seed on top of the drills and not in the furrow, using whole seed of small size or seed well suberized, and for the exporters to send to Cuba only the potato seed that has completed its rest period.

One of the main problems that affect potato production in Cuba is the late blight. Late blight, as a rule, is present in potato fields during December and January and, from that date, is prevalent until April.

Early digging at the point of production in foreign countries and the demand for certified seed for early planting by Cuban growers are responsible, not only for the arrival of seed which has not completed the rest period, but it may also be almost impossible for foreign inspectors

[1]Head of the Grain and Root Crop Bureau.

to detect late blight on shipments moving to Cuba, which perhaps have been infected with blight during the harvesting operation.

It would seem to be that, if seed is held in foreign countries for a certain length of time,—if the seed is infected—that the symptoms of the disease will have sufficient time to "show up" and can be easily detected by foreign agricultural authorities before it is shipped to Cuba. By doing this, they will save a lot of money for shippers as well as for the Cuban growers.

The summer temperature in Cuba sometimes rises above 40° C (104° F), and this temperature is very common during July and August. It is a generally accepted fact that *Phytophthora infestans* cannot withstand a temperature of 40° C (104° F) for more than four hours.

From the above, it seems very reasonable to suppose that, whenever an epidemic occurs in Cuba, one should look for the origin of it in the seed received, as the chances of infection by spores coming through high altitude air currents, which might blow from other infected areas as far away as Hastings or Homestead in Florida, U. S. A., are very remote.

The growing season in Cuba is from September to the middle of April. During these months, the mean temperature is 22°C (73.6 F.). This is low enough to make a good crop of potatoes, which, according to Cuban growers, is 10 to 1 (one bag of seed produces a yield of 10 bags). According to planting distance and the size of seed piece most generally used,—which is 36 inches between rows and 12 inches between hills and a seed piece of one ounce,—an acre will require 963 pounds of seed and will produce a yield of 153 bushels of potatoes, which is at the rate of 10 to 1. The length of day for that period of time is about 10.8 hours.

Although Cuba is considered a tropical country, and the rainfall averages up to 48.25 inches, the monthly average for September and October is 6 inches, and the average for the rest of the growing season is 1.5 inches, which includes the months of November, December, January, February, and March. These facts have caused the growers to use irrigation on their fields. Commercial fertilizers are generally used and many growers apply Bordeaux mixture or dust for the control of Blight.

Seed treatment is very seldom used. This may account for the increase of potato scab damage present in some territories, as the soil in which potatoes are grown belong to the Matanzas clay family (classification of Allyson and Bennett), which has a pH. value between 6.5 and 7.5.

Certified seed most commonly used comes from: Canada; Long Island, New York; Nebraska; North Dakota; Maine; Minnesota; and South Dakota.

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FIELD RESISTANCE TO LEAFROLL INFECTION IN POTATO VARIETIES[1]

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INTRODUCTION

The leafroll disease of potatoes was reported in Washington as early as 1915.[3] Probably, it was locally present in potato plantings prior to that time. Since then it has appeared annually, but until more recently it was not considered a major disease of potatoes. In 1938 it occurred in epiphytotic proportions in commercial plantings in central Washington. Since that year it has been the most destructive potato disease in that area. As a result, a considerable portion of the acreage formerly devoted to the Netted Gem variety (Russet Burbank) has been planted to White Rose. The latter variety is reputed to be more resistant to infection by the leafroll virus than the Netted Gem. Furthermore, White Rose is not known to develop net necrosis of the tubers following current season infection. In 1945 an outbreak of leafroll in the potato-seed-producing area of northwestern Washington resulted in a failure to meet certification standards in a large proportion of the fields.

One solution to the problem would be the introduction of a resistant

[1]Published as Scientific Paper No. 741, College of Agriculture and Agricultural Experiment Stations, Institute of Agricultural Sciences, State College of Washington, Pullman.

[2]Associate Plant Pathologist, Division of Plant Pathology, Washington State Agricultural Experiment Stations.

[3]According to unpublished records of the Division of Plant Pathology, Washington State College Experiment Station.

or tolerant potato variety which would be acceptable to the growers and to the trade. Toward this end, a variety-trial project was initiated in 1944, with the divisions of Horticulture, Entomology and Plant Pathology of the Washington State Agricultural Experiment Stations and other interested agencies in the state cooperating.[4] The following report is limited to that portion dealing directly with the plant pathological phases of the project.

Experimental Design and Methods

The variety trial plots were planted in three major climatic areas in the state. Similar plantings were therefore made at Pullman in eastern Washington, at Harrah in central Washington and at Everson in northwestern Washington.

In 1944, fifty-hill plots of each variety were planted in duplicate. Seventeen varieties and seedlings were planted at Harrah and twenty-one at Pullman and Everson. These were randomized in a single block at each location. No data on the development of current-season symptoms were taken, and all named varieties were recorded as free from tuber-borne leafroll. At harvest time, fifty-tuber samples from each plot were taken and stored for replanting in 1945 and for the determination of leafroll increase.

In 1945, four replications of twenty-five hills each were arranged in four randomized blocks at each location. Certified seed was used when obtainable. In some instances it was necessary to substitute Pullman-grown seed which was one generation removed from certification. In all cases the amount of tuber-borne leafroll in each seed lot was determined by early disease readings before current-season symptoms had appeared. An abundance of leafroll-infected plants was present in or near the plantings each year. This assured an adequate supply of inoculum for field spread. A combined sample of 100 tubers was taken from the four plots of each variety at each location and these were stored for use in determining leafroll increase.

The varieties tested include a number of the older, standard varieties which are grown in the eastern part of the United States, such as Green Mountain, Bliss Triumph and Rural New Yorker, as well as some of those popular in areas of the West, such as Burbank, Netted Gem and White Rose. In addition to these, fifteen recently named varieties and unnamed seedlings were included (table 1).

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[4]At the initiation of the project in 1944, the Division of Plant Pathology was represented by Dr. L. K. Jones. Dr. C. L. Vincent of the Division of Horticulture conducted tests for yields and adaptability; and Mr. B. J. Landis of the Division of Truck Crop and Garden Insect Investigations, U.S.D.A., conducted tests on resistance to flea beetle damage to the tubers.

TABLE 1.—*Field infection of potato varieties with the leafroll virus at three locations in Washington during* 1944 and 1945.

Variety	Pullman 1944	Pullman 1945	Harrah 1944	Harrah 1945	Everson 1944	Everson 1945	Average**
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Katahdin	4.2	4.5	25.0	3.5	0.0	30.5	15.9
Sequoia	0.0	8.6	4.9	41.6	4.2	51.9	26.7
Seedling 5212***	3.1	3.3	26.8*	80.1	9.5	20.2	32.6
Teton	1.8*	14.0	27.6*	65.9	0.7*	31.9*	34.9
Earlaine 2	0.0	48.4*	11.8	63.2	0.0	30.1	35.9
White Rose	4.0	40.0	52.2	29.5	1.5	30.6	38.1
Seedling 5703***	8.5	55.6*	2.6	40.2*	7.8	61.7	40.0
Pawnee	0.0	100.0	0.0	39.3	4.3	26.7	41.6
Rural New Yorker	0.0	57.9*	33.3	49.1	12.3	31.1	42.9
Bliss Triumph	0.0	51.0*	22.7	80.1	3.2	20.3	43.6
Green Mountain	3.2	83.3	26.8	52.6	38.2	19.7	45.6
Gold Coin	0.0	79.8	70.5	32.5	2.7	8.3	48.8
Houma	0.0	55.6	27.8	59.4	5.0	61.3	51.1
Seedling 3708***	8.9	46.4	42.5*	51.6	9.1*	68.0	52.1
Sebago	1.1	85.9	5.9	59.1	6.7	72.6	55.9
Pontiac	6.5	75.7*	45.0*	78.5	2.8	31.5	57.7
Potomac	21.0	77.5*	58.2*	41.4	4.3	55.5	58.1
Earlaine	2.3	77.4*	42.3	82.6	8.9	31.9	58.5
Mohawk	22.1	80.4	51.5	62.6	11.2*	39.8	58.6
Seedling 5657***	4.9	91.3	57.3*	77.3	13.0	61.5	71.9
Netted Gem	3.0	85.2	69.7	79.2	2.0	66.3*	75.1
Chippewa	5.6	85.7	81.8	68.2	5.8	75.9	77.9
Burbank	7.1	99.6	87.5	78.9	12.9	64.9	82.7
Average for 23 vars. and seedlings	4.7	61.2	38.0	57.8	7.2	43.1	49.9
Average for three most susceptible varieties	5.2	90.2	79.7	75.4	6.9	69.0	78.6

*Figures supplied by interpolation in absence of observed values.
**Average of values obtained at Harrah in 1944 and at all three locations in 1945.
***W.S.C., Div. Horticulture numbers, Dr. C. L. Vincent's selections all having Katahdin parentage.

When a variety was not grown in a particular planting, it was necessary to supply data by interpolation in order to arrive at comparable average data.

Varietal Reaction

As may be noted in table 1, leafroll increase was relatively small in 1944 at Pullman (4.7 per cent) and Everson (7.2 per cent), although it was high at Harrah (38 per cent) during the same season. In 1945 the leafroll increase was high at all three locations (61 per cent, 43 per cent and 38 per cent at Pullman, Everson, and Harrah, respectively). Wide differences occurred in amount of leafroll increase in the different varieties. There were some inconsistencies in the reaction of some of them with respect to locations and seasons.

It is assumed that the best measurement of relative resistance is obtained in the instances where leafroll increase was greatest. Consequently, the average of the values obtained for Harrah in 1944 and those obtained at all three locations in 1945 (last column of table 1) was taken as the basis for comparing the varieties. On this basis, Katahdin was the most resistant of the varieties included in the test, having an average leafroll increase of only 16 per cent, although it showed a maximum leafroll pickup of 30 per cent at Everson in 1945. Sequoia was the second most resistant variety with an average leafroll increase of 27 per cent, and a maximum of 52 per cent at Everson in 1945. At the other end of the series the varieties, Netted Gem, Chippewa and Burbank, show a high average leafroll increase of 79 per cent and a maximum of 90 per cent at Pullman in 1945. The remaining eighteen varieties and seedlings form an almost continuous series between these two extremes and encompassing a range from 33 per cent to 59 per cent leafroll increase. Although there seems to be no basis for further grouping of these varieties, the extremes of the intermediate group appear to represent real differences in reaction to field exposure to leafroll infection. It is interesting to note that Teton, Earlaine 2 and White Rose are among the more resistant of this intermediate group of varieties. Bliss Triumph and Green Mountain are intermediate and Sebago, Earlaine and Mohawk are among the least resistant.

Weather in Relation to Field Infection

An explanation of differences in field spread of leafroll at the different locations and during the two seasons was sought in the weather records for the areas concerned. Published results of experiments with *Myzus persicae* Sulz. (6) have shown that flights of this important aphid vector of the leafroll virus do not commonly occur at temperatures below

65° F. nor above 75 per cent relative humidity. The optimum flight range was 70° F. to 90° F. (13).

When the daily maximum temperatures and relative humidities (per cent at 10:00 a. m.) at the three locations were compared, it became evident that relative humidity was not a limiting factor for aphid flight at any of the three locations during the growing season of 1944. In 1945 the relative humidity rose to 75 per cent or above for a brief period at the beginning of the season at Pullman and at the end of the season at Everson.

The temperature, on the other hand, appears to have been the main climatic factor influencing aphid flights at these locations in both years. In 1944 at Pullman and Everson the daily maximum temperature remained below that favorable for aphid flights until a little after the middle of the growing season. It then reached or exceeded 70° F. for a brief period at these two locations and again at the end of the season at Everson only. These relatively low temperatures were associated with a low rate of leafroll spread in the field. At Harrah the daily maximum temperature reached the level favorable for aphid flight some time before the middle of the growing season and remained well above this level until harvest. This situation was accompanied by a high rate of leafroll spread in the field.

In 1945, at all three locations the daily maximum temperatures rose to optimum for aphid flight long before midseason and remained in the favorable range until after harvest. The field spread of leafroll was high at all three locations in 1945.

Discussion

Katahdin has been mentioned frequently in the literature as being resistant to infection by the leafroll virus (2, 3, 5, 11, 12). Likewise, Green Mountain and Chippewa have been reported (3, 11, 12) as very susceptible to field infection by this virus. To this extent the results here reported are in harmony with those obtained by other investigators. On the other hand, the variety, Houma, which has been rated as more resistant than Katahdin by some investigators (12)[5], appears to be nearly as susceptible as Green Mountain under the conditions of these tests. This and other inconsistencies raise the question of the nature of the resistance which we are attempting to measure.

Resistance to the leafroll virus, itself, apparently does not exist in the material so far tested, since all of the potato varieties may be infected artificially with it, and when infected, develop the symptoms

[5]And also in correspondence with F. J. Stevenson dated January 8, 1947.

characteristic of the disease. Nevertheless, some varieties tend to escape infection in the field more frequently than do others. Evidently the basis for field resistance is to be sought among the many factors affecting the complex relationships among virus, host, vector, and environment.

One of the more obvious considerations which comes to mind is the one of varietal suitability for development and sustenance of aphid populations. Very marked differences exist among varieties in this respect (1). However, it has been shown that the resistant variety, Katahdin, favors the rapid reproduction of the aphid, *Myzus persicae* Sulz., which is considered to be the main vector for the leafroll virus, and frequently supports large populations of this aphid (8, 9). Also the leafroll-susceptible variety, Burbank, has been classified as an unfavorable host for *M. persicae* (9). The variety, Sequoia, on the other hand, is reputed to be resistant to aphids (1, 9). In this case, resistance to the leafroll vectors may enter into its escape from virus infection in the field.

The differences in feeding habits of four potato aphids have been used to explain the differences in their abilities to transmit leafroll virus to potatoes (7). Those feeding most consistently in the phloem are more efficient in this capacity than those feeding in the extra-vascular tissues. This suggests the possibility that anatomical differences among potato varieties may affect the efficiency with which aphids are able to pick up the virus from infected plants and transmit it to healthy ones. In connection with potato virus Y it was found that a positive correlation existed between the ability of *M. persicae* to infect several potato varieties and the resistance exhibited by these varieties to natural infection under field conditions (2). The small amount of work done with the leafroll virus along this line does not indicate any such relationship. Thus the resistant variety, Katahdin, as well as the susceptible variety, Green Mountain, proved to be very susceptible to infection when artificially infested with leafroll-viruliferous *M. persicae* (4). Likewise, no marked differences were found among seven European varieties in degree of resistance to leafroll when similarly infested (10).

Numerous other factors could be mentioned which might contribute to, or detract from the complex which we term "field resistance." It seems evident to the writer, therefore, that progress toward the development of leafroll-resistant varieties will continue to be slow and tedious until more is known about the nature of such resistance.

Summary

In recent years the leafroll disease of potatoes has become a major problem in the production of potatoes for seed and table stock in Washington. In order to find a substitute for the very susceptible variety,

Netted Gem, variety tests were undertaken at three representative locations in the state. Data representing exposure to natural infection in the field in 1944 and 1945 indicate that the variety, Katahdin, is the most resistant of the twenty-three varieties tested, while Sequoia showed considerable resistance. The varieties, netted Gem, Chippewa, and Burbank, were the most susceptible under the conditions of these tests. The daily maximum temperature appeared to be of great importance in affecting the rate of field spread of leafroll at the different locations and during the two seasons through its effect upon aphids flights. The relative humidity was a limiting factor for field spread in only a few instances.

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RING ROT SURVEY 1940-1947

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The data included in this survey are based on the inspection records of those states producing certified seed and have been obtained through correspondence with the various officials responsible for certification work in their respective states. The report is therefore limited to seed and does not attempt to include estimates of the incidence of ring rot in table stock potatoes. The percentage estimates are based on the acreage rejected for ring rot compared with acreage entered for inspection. In a few instances the estimate is based on the number of fields rejected. Each state is listed under a number and it is indicated which method of percentage estimate was used. For purposes of comparison the average per cent of ring rot for each state and for each year has been calculated. The average for all years and states was calculated by adding all observations and dividing by the total number. In making comparisons it should be remembered therefore that the averages are not weighted, that states differ in their method of estimate and that some states did not report certain years.

An examination of the data given in the table clearly shows ring rot to be a problem of real concern to seed certification agencies throughout the United States. Progress in controlling the disease was apparently made during the years 1940 to 1942 but during 1943, 1944, and 1945 the amount reported gradually increased, and the 14.84 per cent reported for 1946 probably represents a significant build-up in prevalence. Correspondence from the various states indicates, and it is clearly shown in the table that the increase was quite general, extending from extreme northeastern United States through to the Great Plains states in the West. Symptoms of the disease occurred fairly early in the season and were quite typical, suggesting that some overall factor or factors might be responsible. It is a known fact that high temperatures favor development of the disease with corresponding symptoms. However, it does not appear that warmer temperatures prevailed in 1946 than in either 1945 or in 1947. For example, an examination of both soil and air temperatures taken in Northern Wisconsin show 1946 to be cooler on the average than 1947, particularly during the critical month

*This report was compiled by the writer, as Chairman of the Seed Certification Committee of the Potato Association of America. Acknowledgment is made of the certification officials in the various seed-producing states for the data furnished.

RING ROT SURVEY -- 1947

PER CENT REPORTED

State No.	Estimate Based on	1940	1941	1942	1943	1944	1945	1946	1947	Average
1.	—	NR*	4.5	3.3	10.0	9.6	NR	NR	NR	6.85
2.	Acreage	7.4	3.1	2.6	10.0	2.4	3.0	4.0	3.0	4.43
3.	Fields (?)	3.4	0.8	1.2	11.0	6.8	25.0	15.0	6.0	8.65
4.	Acreage	2.1	0.7	1.8	3.7	2.9	5.0	10.41	13.3	4.98
5.	Acreage	5.4	4.1	5.1	5.8	7.8	5.1	16.7	8.0	7.25
6.	Acreage	0.7	7.2	3.4	4.4	15.5	13.1	23.6	6.8	9.33
7.	Fields	6.1	3.1	10.9	7.4	10.8	41.0	30.8	17.9	17.12
8.	Acreage	NR	NR	NR	NR	NR	9.3	4.0	none	4.43
9.	Acreage	2.0	1.1	1.1	0.2	none	4.87	12.6	11.0	4.10
10.	Fields	0.6	7.1	2.0	1.8	10.0	none	17.0	2.0	5.06
11.	Fields	3.8	2.1	0.3	1.1	3.1	3.4	11.9	4.2	3.73
12.	Acreage	20.3	13.4	12.6	13.3	17.7	19.0	22.0	14.0	16.53
13.	Acreage	3.2	4.4	3.9	2.7	3.6	NR	5.5	.7	3.42
14.	Acreage	NR	11.6	6.8	14.8	10.0	8.0	11.6	3.7	9.50
15.	Acreage	none	none	none	1.2	none	3.0	45.0	10.0	7.40
16.	Acreage	10.6	5.8	4.1	2.4	1.6	4.8	1.4	5.6	4.53
17.	Acreage	2.3	2.3	none	7.6	5.6	6.0	36.8	9.5	8.76
18.	Acreage	10.0	1.4	none	1.6	1.2	none	none	6.0	2.52
19.	Acreage	NR	6.9	6.2	19.4	0.1	9.7	7.8	6.7	9.40
20.	Acreage	23.5	13.4	5.3	7.6	8.4	14.3	17.9	17.1	13.43
21.	Fields	2.4	5.0	4.8	2.2	2.0	1.6	2.9	.01	2.61
Average		6.10	4.90	3.77	6.41	6.85	9.27	14.84	7.27	7.44

*Not Reported

of August. The rejections because of ring rot on the other hand were somewhat less in 1947 than in 1946 under Wisconsin conditions. Many other explanations, some of which are quite plausible, might also be made. It is conceivable than an increasing number of seed stocks could be carrying ring rot during the years 1943 to 1945 because of conditions limiting the development of symptoms. This situation followed by a year such as 1946 when the symptoms were pronounced, could account for this high rejection percentage. As might likewise be expected the rejections dropped sharply in 1947 or roughly one-half those of 1946. The general situation could be considerably aggravated by the rapidity with which ring rot can spread from diseased to healthy seed stocks. On the other hand, it is expected that considerable control could be obtained through winter trials of adequately sampled seed stocks in the south and in the greenhouse, and, in additional instances, through added inspections of the seed in storage. Again the records in Wisconsin reveal that in a large majority of instances the presence of ring rot in a seed stock could be traced to contamination. The problem becomes more complex in instances involving the production of more than one variety. The difficulties involved in finding one diseased specimen where large numbers of plants or tubers are involved is too familiar a one to need further elaboration, but it should be pointed out that a complete history of a seed stock in the hands of several operators may often prove valuable. Varieties apparently differ in degree of susceptibility often being referred to as "latent" or "symptomless" carriers, particularly Pontiac anl Katahdin. It is also possible there are basic differences or even strains of the organism causing considerable variation. Planting dates, spray programs, early frosts, and early vine killing practices should not be overlooked as contributing factors to an analyses of this situation.

Without exception all states reported control programs based on (1) the use of clean seed and (2) a sanitation program. At the present time it appears that most states have decided they cannot completely eradicate ring rot and are therefore following various practices directed toward control. That this approach is meeting with success in a practical way comes from two sources. First, nearly all states reported finding one-tenth of a per cent or less in fields rejected, despite the fact that many of these fields were often examined after ring rot was found. Secondly, several of the southern states reported they have had little experience with ring rot in recent years but that occasionally ring rot was of concern. Few actual records are kept in seed-consuming states, the exception being Louisiana, and they report inspections made on carlots of seed shipped into their state as follows:

	1944	1945	1946
Cars inspected	662	339	399
Cars infected	12	10	10
Per cent	1.8	2.9	2.5

Although no attempt is made to justify the incidence of ring rot reported through this survey, it is felt that this very complex problem needs careful study and analyses by those responsible for seed work,—and certainly by research men. The added burden or expense required to control the disease only adds to production costs from the seed producer to the consumer. A large part of this cost could be eliminated if, for example, an immune variety were developed. But the hard fact remains at present that ring rot is of vital concern to a grower who faces economic loss because of the disease regardless of the nature and complexities of the problem or what control practices may now be in effect.

ABSTRACTS OF PAPERS PRESENTED AT THE ANNUAL MEETING OF THE POTATO ASSOCIATION OF AMERICA, CHICAGO, ILL.

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Soil fertility investigations with potatoes in Wisconsin. K. C. Berger

Soil fertility investigations have shown that the following changes have taken place in some Northern Wisconsin potato soils since they have been under cultivation: Soil acidity has increased from medium acidity (pH 5.5 to very strong acidity (pH 4.5); the available phosphorus content of the cultivated soils is three to five times that of the virgin soils; available potassium has decreased about 50 per cent. This shift in plant nutrients has been brought about largely by an unbalance in the fertilizer used.

Field experiments have shown that yields of potatoes can be increased as much as 140 per cent by the application of 1,200 pounds per acre of 6-6-18 fertilizer broadcast plus the application of 800 pounds per acre of 3-12-12 at the side of the seed in the row. The high potash fertilizer is necessary at present, because of the low potassium content of the soil.

Because of the increase in acidity, these soils are now deficient in available magnesium but have an excess of soluble manganese. Both of these conditions can be rectified by small applications of finely ground

dolomitic limestone which have increased potato yields as much as 30 per cent. The application of soluble magnesium in the fertilizer is recommended in addition.

The effect of different rates of application of 2, 4-D on the yield of potatoes. R. H. BRADLEY, N. K. ELLIS

Because of the present high cost of labor necessary for hand weeding, this experiment was conducted to ascertain the possibility of including a chemical weed killer such as 2, 4-D in the regular potato spray mixture.

The results of this experiment indicate that control of weeds in potato fields may be made possible by incorporating a weed killer with the regular potato spray. The application of .875 pounds per acre of 2, 4-Dichlorophenoxyacetic acid applied in the form of 70 per cent sodium salt resulted in controlling the weeds and there was no significant decrease in yield.

Promising new chemicals for the control of potato diseases and insects. JOHN CAMPBELL

Two potato spray experiments were conducted in New Jersey on the Katahdin variety in 1947. One was designed to test the merits of several fungicides, DDT being used as the insecticide with each. In the other experiment several new insecticides, in combination with Bordeaux, were compared. All plots were sprayed eight times with a 4-row power sprayer. No early blight, *Alternaria solani* was noted and late blight, *Phytophthora infestans*, was so slight that the effectiveness of the fungicides could not be evaluated. Flea beetles, *Epitrix cucumeris*, and aphids *Macrosiphum solanifolii*, were very abundant but very few leafhoppers, *Empoasca fabae* were present.

Plots sprayed with Dithane D-14 (2 qts. -100) produced significantly higher yields than those receiving DDT (1½-100), Bordeaux (8-8-100), Phygon (1-100) or C-O-C-S (4-100) and approached significance in yield when compared with those receiving Zerlate (2-100) and parzate (2-100) but did not greatly outyield those sprayed with Tri-Basic Copper (4-100). Zerlate and Parzate plots outyielded C-O-C-S, whereas Tri-Basic Copper plots produced substantially higher yields than those sprayed with DDT alone, Bordeaux, Phygon or C-O-C-S.

Among the insecticides tested, 15 per cent Parathion (2-100) formerly known as 3422, gave excellent control of aphids, but poor control of leafhoppers and flea beetles and resulted in a significantly higher yield than plots sprayed with 50 per cent Chlordane (2-100), 50 per

cent Rhothane (2-100) or 25 per cent Toxaphene (2-100) and closely approached significance in yield over 50 per cent DDT (1-100). The use of 25 per cent DDT emulsion (1 qt.-100) has also resulted in very good control of aphids and leafhoppers but only fair control of flea beetles whereas 50 per cent DDT (2-100) gave good control of flea beetles and leafhoppers and a fair control of aphids. The use of 25 per cent BHC (2-100) gave fairly good control of aphids but relatively poor control of leafhoppers and flea beetles, although the yield obtained was second only to that produced by Parathion and was significantly greater than the yields in plots sprayed with Chlordane, Toxaphene or Rhothane. Toxaphene caused severe injury, gave poor control of all insects and resulted in a significantly lower yield than any material tested.

Forecasting late blight in Eastern Virginia in 1947. HAROLD T. COOK

The method of forecasting late blight epiphytotics described last year was put to a practical test during the 1947 season. Beginning on the 8th of May, the cumulative rainfall and mean temperatures were plotted each day Forecasts based on the graphs were issued at weekly intervals from the 15th of May to the 5th of June. All of these forecasts stated that the weather conditions were unfavorable for late blight and that spraying or dusting to control the disease was not necessary at that time.

The forecasts proved to be correct. There was no epiphytotic in Eastern Virginia and over 90 per cent of the potato and tomato acreage was entirely free of the disease. The crops also were free from other serious leaf and fruit diseases.

Since it would have cost approximately $2,000,000 for routine spraying or dusting of the 60,000 acres of potatoes and tomatoes, the elimination of the needless use of fungicides is of considerable economic importance.

A graph showing the moving 7-day average rainfall and temperature was developed to supplement the cumulative graph. The moving graph was more accurate for analyzing the late blight-weather relations throughout the entire season and also aided in correcting the unusually heavy rainfall early in the forecasting period.

The development of stem end discoloration in Bliss Triumph potatoes held in warm storage. M. W. FELTON

In Nebraska the discoloration of vascular tissues in the stem end of tubers, as distinguished from the stem end rot, is the most common tuber symptom of the Fusarium wilts. Although it has been demon-

strated experimentally that the stem end rot continues to develop at a favorable temperature after harvest, there has been a general belief supported by several tests in both cellar and cold storage that the vascular discoloration did not increase appreciably during storage. This concept was a variance with reports from other sections and with inspection records in certain instances.

With the possibility that higher storage temperatures might give different results, 24 samples from dry land rotation plots were taken from cellar storage in the winter of 1945, and one-half of each sample was placed at 45° F., and the other at 75° F. When graded eight weeks later, the lots held at the low temperature averaged 3.5 per cent severe stem end discoloration, those at the high temperature, 24.

In 1946, dry land potatoes held in cold storage until March, and carrying 0.8 per cent severe stem end discoloration, were subjected to storage at 40°, 50°, 60° and 70° F. After seven weeks the percentage of stem end discoloration remained practically unchanged at 40°, raised to 2.0 per cent at 50°, to 12 at 60°, and to 22 at 70°. It is evident that very important increases in stem end discoloration may take place in dry land Nebraska potatoes held in warm storage.

The effect of temperature, moisture and nitrogen on development of leaf roll symptoms in the Irish potato. M. W. FELTON

Inconsistent leafroll readings in Nebraska certified fields planted from the same parent seed lots prompted investigation into the factors affecting development of leafroll symptoms. Based on leads from field observations, greenhouse experiments were conducted during the winters of 1945 and 1946 on the effect of temperature, moisture, and nitrogen on the rate of symptom development in Triumphs affected with leafroll. Where known leafroll plants and healthy checks were planted at 60° and 70° F. in dry and wet soils, first leafroll symptoms distinguishing the diseased plants appeared seven days after emergence in the wet series, and two weeks later in the dry series. At 80° in the wet series, the first leaf rolling appeared only after six weeks, and at no time did definite leaf rolling, distinguishable from the checks, appear in the dry series at this temperature. When the plants were grown in sand culture with very low nitrogen, an exaggerated rolling as distinguishable from a folding and cupping in the healthy checks appeared at six days at the 60° and 70° temperatures, and at ten days at 80°. In the high nitrogen series, rolling at the two lower temperatures appeared at approximately two weeks, whereas at 80° no definite and permanent rolling ever appeared, however, the leafroll plants were more erect, with

stiff, straight petioles, a characteristic which might aid in distinguishing leafroll at high temperatures.

Although healthy and leafroll plants could not be distinguished with certainty in the + nitrogen series at 80°, the total yield of the leafroll plants was still less than one-half that of the healthy plants.

It would appear from these experiments, that certain combinations of temperature, moisture and fertility may delay the appearance, or even mask certain symptoms of leafroll.

Some histological features of potato stem necrosis associated with Actinomyces scabies. W. J. HOOKER AND J. E. SASS

Of the varieties of potato tested to date, those known to be susceptible to tuber scab, *Actinomyces scabies* (Thaxt. Gussow) exhibited considerable necrosis of stems resulting from infection by the scab organism, whereas, varieties resistant to tuber scab were likewise resistant to stem necrosis. When plants were grown in the greenhouse in sterilized peat soil artificially infested with *A. scabies,* infection was often established in the stems through unwounded surfaces, away from stolons and secondary roots. In this type of lesion, the susceptible varieties, Red Warba, Cobbler, Pawnee, Katahdin, and Chippewa showed either no periderm or at most a poorly developed, discontinuous periderm, with actinomycetous filaments abundant in the cortical cells. The stems of the resistant varieties, Menominee, Cayuga, and two unnamed clones, showed well developed and continuous periderm with sparse intracellular mycelium. This relationship did not hold consistently with resistant and susceptible varieties naturally infected in the field. Where stem infection in the field took place through natural wounds such as longitudinal splits or at points of emergence of stolons and secondary roots, periderm formation was generally poor even in resistant varieties, and mycelium was often abundant.

Evidence of parasitic activity of Actinomyces scabies on seedling roots. W. J. HOOKER AND J. E. SASS

It was previously reported that seedling roots of a number of plants developed severe necrosis when grown in soil-water agar artificially infested with *Actinomyces scabies* (Thaxt.) Gussow, whereas roots of the same species showed no necrosis with cultures non-parasitic to potato. Necrosis of a comparable type, although less severe developed on soybean and wheat roots grown in quartz sand artificially infested with *A. scabies.* There was no evidence that such necrosis was produced by a water soluble substance secreted by *A. scabies* on potato-dextrose agar. Sectioning demonstrated *A. scabies* filaments abundant

in the rhizosphere and in the epidermal and cortical cells of these roots grown in agar even though the root was not noticeably necrotic. *Actinomyces* sp. were demonstrated by dilution plate counts to be appreciably more abundant in the rhizosphere of field-grown oat roots than in soil in which there were no roots. Roots of Clinton oat plants grown in the peat soil in northern Iowa were sectioned and the filaments of an actinomycete were demonstrated in the tissue.

Physalis angulata L. a test plant for the potato leaf roll virus. CHARLES HOVEY AND REINER BONDE

P. angulata, a wild ground cherry, was found to be a good test plant for the detection of the potato leaf roll virus. This species, when inoculated with viruliferous aphids, develops pronounced symptoms, the infected plants becoming severely stunted with chlorotic and rolled leaves.

The use of *P. augulata* as a test plant for the leaf roll virus has certain advantages when compared with the potato. It is easily propagated in the greenhouse from true seed, is relatively small in size, and the presence of the virus is readily detected about 10 days after inoculation.

This test plant has been used with success in a study of the aphid-leaf roll virus relationship.

Potato-vine killers. WM. G. HOYMAN

Experience with potato-vine killers during the past three years has indicated that some of the materials have proved effective in the Red River Valley of North Dakota. Weed killer X 1 (potassium cyanate), Sinox General (dinitro ortho secondary amylphenol) with ammonium sulphate and diesel oil, and Dowspray 66 Improved (dinitro secondary butylphenol and mineral oil) with aluminum sulphate have given the most rapid kills when applied as sprays; the rapidity of kill depending on the concentrations of the ingredients. Pulverized AERO Cyanamid dust gave a slow kill and especially during the absence of dew. In addition to chemical vine killers, a tractor-mounted, hammermill type of vine chopper has been used to destroy the vines. The discoloration found in and adjacent to the vascular tissue of tubers harvested from treated vines was positively correlated with the rapidity of kill and was less when vines were killed as they approached maturity. Tubers harvested from untreated vines cut at the ground level showed the same discoloration. Preliminary experimental evidence obtained in 1947 indicated the amount of moisture available during the growing season, and the stage of maturity at the time the vine killers were applied, affected the amount of tuber discoloration. The preliminary evidence was supported by observations in commercial fields.

Indicator plants for studies with the leaf roll virus of potatoes.
HUGH C. KIRKPATRICK

Although the potato leafroll virus is readily transmitted to most potato varieties, the potato has limitations for use as a tool in studies of this virus and its vector, *Myzus persicae* Sulz.

A survey of other Solanaceous plants has shown that among those species susceptible to the virus, *Datura Stramonium*, *Physalis angulata*, and *Physalis floridana* rapidly develop distinct symptoms under most conditions and possess other characteristics that make them useful as indicator plants for the leafroll virus when inoculated into seedlings.

Transmission percentages from single insect feedings generally range around 20 to 40 per cent for *P. angulata;* 50 to 70 per cent for *Datura Stramonium;* and 70 to 90 per cent for *P. floridana*, and, in some cases, 100 per cent transmission has been observed with this host.

The relationship between maturity, yield, color and cooking quality of Bliss Triumph potatoes. R. KUNKEL, L. A. SHALL AND A. M. BINKLEY

This experiment was conducted for the purpose of determining the best time to harvest early potatoes from the standpoint of yield, color and specific gravity and to determine how long potato tubers could be left in the ground after the tops had died naturally or had been killed with a vine killer without losing too much color or cooking quality. It was the common opinion among early potato growers of the Gilcrest area that the color of Bliss Triumph potatoes faded rapidly after the vines were dead. Poorly colored Bliss Triumphs were frequently docked in price when the market was low.

Sample lots of tubers were dug at weekly intervals over a four-week period and each week, records on the aforementioned factors, were taken. At the same time that samples were being dug the tops were pulled up in the adjacent row but the tubers were left in the ground to be harvested at the end of the experiment. Thus it was possible to get indication as to how much quality had been lost by leaving the tubers in the soil without any vines for varying lengths of time.

It was found that yield continued to increase as long as the vines were alive, that color faded from early harvest to an almost constant level, that there was a highly significant difference in color in favor of the tubers which were harvested, while the tops were still green and those which had the tops pulled up and were not dug until the end of the experiment and that specific gravity increased at first and then decreased as the season became hotter and the vines began to die.

The effect of chemical vine killers on the quality and yield of Red McClure and Triumph potatoes. R. KUNKEL, A. M. BINKLEY AND W. C. EDMUNDSON

Potato vine killers have come into vogue in Colorado during the last two years for the purpose of lengthening the harvest period and possibly to toughen the skins in order to reduce the amount of scuffing and mechanical abrasion. The purpose of the experiment was to determine the effect of prematurely killing the vines on yield, color, specific gravity, and stem-end discoloration.

In 1946 potato vines were sprayed with Sinox and Dowspray 66 at Greeley and in the San Luis Valley. In 1947 potato vines were sprayed with Sinox, Dowspray 66, sodium nitrite, Hammond's Weed Killer, Fairmount Weed Killer, and Ammonium Sulphate about two weeks before harvest in both potato areas. Yield, grade, color and specific gravity data were taken within a month after harvest, but the tubers were not cut for stem end discoloration until approximately 75 days after harvest during which time the tubers were stored at room temperature in case of the Red McClures and about 40° F. in the case of the Bliss Triumphs.

In 1946 killing the vines on Bliss Triumph potatoes at Greeley failed to produce a significant effect insofar as any the factors measured were concerned. Killing the vines in the San Luis Valley and leaving the tubers in the ground an additional 23 days resulted in a significantly poorer color, lower specific gravity, and increased stem end discoloration compared with that of the untreated check.

In 1947, at Greeley, premature killing of the vines caused no effects significantly different from the check on any of the factors considered, probably because a killing frost occurred two days after the treatments were applied.

In the San Luis Valley killing the vines two weeks prior to harvest resulted in a significantly poorer color, lower specific gravity and a decrease in the percentage by weight of the amount of tubers over 2 inches in diameter. There was no difference between treatments insofar as stem end browning is concerned. It is quite possible that some net necrosis was interpreted as stem end discoloration in 1946.

Dowspray 66 plus copper sulphate was almost as effective in killing the vines as Dowspray 66 plus aluminum sulphate. Dowspray 66 plus copper sulphate is toxic to late blight spores according to determinations made by the plant pathology department. It may have a place where late blight is a factor.

The difference in the amount of scuffing between the tubers on which the vines were killed sixteen days before harvest, was difficult to observe.

Effect of leafhopper control with DDT dust on length of growing season, quality and yield of seventeen potato varieties.
M. B. LINN, J. W. APPLE AND C. Y. ARNOLD

Seventeen potato varieties were planted in Illinois in 1946 to determine the effect of leafhopper control with DDT on length of growing season, quality (starch content) and yield. One-half (three replicates) of two separate plantings was dusted with DDT as often as needed for leafhopper control. No fungicides were used. In an early planting (April 13—Urbana—10 varieties) highest leafhopper populations in all varieties averaged 25 nymphs to 5 leaves in undusted plots and zero in the dusted. The growing season of Red Warba, Early Ohio and Triumph was lengthened through leafhopper control by 20 days; and that of Mesaba, Pawnee, Pontiac, Chippewa, Cobbler and Erie by 15 days. Increases in tuber quality expressed in specific gravity varied between 46 per cent for Pontiac to 9 per cent for Mesaba. Yield increases from DDT ranged from 203 per cent for Triumph to 6 per cent for Erie. In a later planting (May 23—Cook County—11 varieties) highest leafhopper populations in all varieties averaged 43 nymphs to 5 leaves in undusted plots, and 3 in dusted. The early frost prevented taking complete length-of-season records. The tuber quality increases ranged from 16 per cent for Teton to zero for Sequoia. Extremes in yield increases from dusting with DDT were 243 per cent for Pawnee and 74 per cent for Sequoia. With the exception of dusted plots of Erie, early blight was not a factor in yield or quality reduction in either planting.

Studies on the host range of the golden nematode of potatoes, Heterodera rostochiensis. W. F. MAI ANL B. F. LOWNSBERY JR.

One hundred and seventy-one species of the flowering plants, representing 39 families, were tested for susceptibility of the roots to attack by *Heterodera rostochiensis* Wollenweber, the cyst-forming nematode responsible for the golden nematode disease of potatoes. Many of the commercial crops and the weeds of New York State, especially those species belonging to the family Solanaceae, were included in this test. In addition to the potato, only tomato and bittersweet (*Solanum Dulcamara* L.) were found to be susceptible. Thirty-seven American varieties of potatoes and 43 varieties of tomatoes were all strongly attacked. When 16 varieties of potatoes and 6 varieties of tomatoes were grown in adjacent replicated and randomized plots the number of nematodes attacking the roots of potatoes was significantly higher than the number attacking tomato roots. This difference was greater where the number of cysts per root system was used as an infection index than where cysts

per gram of root tissue were used. In this experiment there were also significant differences between the number of nematodes attacking the roots of the different potato varieties. However, all varieties were heavily attacked; hence these differences are of limited commercial importance.

A comparison of chemical tests with the ultraviolet technique in testing potatoes for virus diseases. JOHN G. MCLEAN, ROBERT KUNKEL AND GEORGE LANE

German literature since 1930 shows considerable interest in various chemical tests of the potato tuber to detect virus diseases. These results will be compared with the ultraviolet light technique for the detection of virus diseases in the tuber. Special emphasis is placed on the differential reaction of various varieties to both types of testing.

Use of certain new materials in the control of potato insects in Michigan. W. F. MOROFSKY AND J. H. MUNCIE

Field tests of insecticides and fungicides were made at the Lake City Experiment Station during 1947 using the Menominee variety. The spray plots consisted of four rows 180 ft. long, randomized and replicated three times. The dust plots consisted of eight rows, 200 ft. long. Yield data were taken from four harvestings of the two center rows fifty feet long in each plot. This soil was of clay loam and of irregular fertility. All potato fields were irrigated five times during the season.

Parathion (3422) benzene hexachloride, pyrethrins, nicotine sulfate (liquid and dry concentrate) and dry, wettable and liquid DDT were used in combination with various fungicides as sprays and dusts. Our tests comprised 15 dusts and 19 sprays, and applications were made every ten days beginning July 15th to September 19th. Insect counts were recorded 2-4-6-8 days after each application.

The best control of potato insects in general was accomplishel by applications of DDT in either sprays or dusts. Parathion (3422) was outstanding in the control of potato leafhopper by dusting, whereas applications of 5 per cent DDT gave almost complete control of six-spotted leafhoppers, flea beetles, and tarnished plant bugs. Benzene hexachloride as a dust ranked with DDT in the control of tarnished plant bugs, although this was not true in the control of leafhoppers nor in the spray combinations. No late blight was present. There were no significant differences between materials in the control of early blight because of early killing frost.

In the spray plots, the highest yields of U. S. #1 tubers were obtained from Bordeaux 8-4-100 plus benzene hexachloride, and in the dust plots, Parathion (3422—1 per cent). The insect counts did not correlate with the yields of our potatoes.

A virus causing internal necrosis in White Rose potato.
JOHN W. OSWALD

White Rose potato plants exhibiting severe leaf, stem and tuber necrosis were observed in California in 1946. An investigation showed this to be caused by a virus, easily transmissible by mechanical means. The first generation symptoms consist primarily of internal necrotic browning of veins, petioles, and stems; extreme at the nodes, followed, in severe cases, by collapse of the entire plant. Affected leaves show irregular necrotic areas and often chlorotic blotches. As the disease progresses these may shrivel and hang. Top leaflets become rugose and tightly curled and the leaves roll downward. Tuber necrosis occurs first just under the skin giving the surface a purplish cast. Later these areas become sunken and corky and necrosis often spreads through the entire tuber. In the second generation internal necrosis is less severe. Potato seedling 41956 reacts similarly to White Rose. Free from the latent virus, the necrotic virus induces a chlorotic mottle in pepper, irregular yellow mottle in *Nicotiana rustica*, and green vein banding in *N. glutinosa* and *N. tabacum*. Thermal inactivation is between 50° and 55°C and longevity *in vitro* between 48 and 60 hours. The virus properties and host reactions indicate a possible relationship to virus Y.

Yield and grades of blight resistant potatoes grown in twenty different locations in New York State. ARTHUR J. PRATT

Twenty varieties of potatoes were planted in 20 different locations covering Long Island and all sections of upstate New York. Older 4-H Club boys served as cooperators. The layout was a randomized Latin Square with each replication at a different location. Green Mountain, Katahdin and Rural were used as standards. The other 17 varieties were all highly blight resistant and were developed by Dr. Reddick of Cornell. Eight of the latter were named varieties and nine were numbered seedlings. They were to be sprayed with DDT only. However, due to the inconvenience of not using the regular spray, 3 or 4 of the plots did receive some copper.

All plots were harvested after frost had killed the plants. Some varieties in some locations were mature before frost. The number and weight of tubers was recorded. The tubers were sized into those over 2 inches and those under 2 inches in diameter. Those over 2 inches were divided into those that were of No. 1 quality and those that were below No. 1 quality because of (1), scab; (2), misshapen and second growth; (3), sunburn and, (4), tuber rot. Tubers injured by insects

or mechanical means were included with the No. 1's as these defects were considered unrelated to the genetic make-up of the variety.

Fourteen of the 17 new varieties produced higher average yields than any of the three standards. The data show the number of times that each variety was above average and the number of times that it was above each of the standard varieties. The tests indicate that some of these varieties produce tubers as good looking as Katahdin tubers under a wide variation in conditions.

Due to a bad blight season in most of the area, the importance of the blight-resistance factor was evident.

Effect of location and date of planting on yield and grade of certain varieties of potatoes. Arthur J. Pratt, W. C. Kelly, and G. F. Somers

Cobbler, Katahdin, and Fillmore potatoes were planted at early, midseason, and late planting dates at four locations in upstate New York. The locations were selected to include muck and upland soil, high and low elevations, and cloudy and sunny areas. Daily rainfall, thermographic air temperature, and illumination records were kept at all locations. Thermographic soil temperature records were kept on the muck plot and on the nearby upland plot. Three harvests were made at each location, the first when the Cobblers matured, second when the Katahdins matured, and the third when the Fillmores matured or were killed by frost.

All plots at all locations were sprayed regularly with Bordeaux and DDT.

Immediately after harvest each lot was weighed in air and water to determine the specific gravity of the tubers as well as the total yield of the plot. All lots were run over a commercial sizer to separate those over and under 1⅞ inches in diameter. Tuber counts, as well as weights, were obtained on all lots; the green weight of tops was obtained at the first and second harvest.

The results showed a significant difference (1 per cent level) between locations, varieties, times of planting, and times of harvest in both the total yield and in the per cent of small tubers. The differences were also significant in most of the first and second order interactions. Specific gravity differences were also significant under all treatments and with most first order interactions.

The data indicate that it is not safe to make variety recommendations based on one planting date in one location, even though the test is well-replicated.

Resistance of new potato varieties to common scab in Wisconsin.
G. H. RIEMAN AND R. W. HOUGAS

Field experiments were conducted for four years to determine the resistance of ten newly named, two standard American and one scab-resistant European varieties of potatoes to *Actinomyces scabies*. An analysis of variance showed significant varietal differences but all varieties showed some susceptibility. The resistance of two newly named varieties (Ontario and Menominee) compared favorably with the reaction of a European variety (Hindenburg) which has been used extensively in scab-resistant breeding programs in America. A russet-skinned clonal selection (Russet Sebago) obtained from another newly named smooth-skinned variety (Sebago) exhibited significantly more scab resistance than its parental form.

Chemicals for control of the golden nematode of potatoes. C. G. SCHMITT

All the following chemicals, namely, allyl bromide, D-D, trimethylene bromide, ethylene bromide, and Iscobrome D were rather effective in killing of the cysts of the golden nematode in a pot test at 23 gallons per acre. Of the chemicals used, the only ones which eradicated under these ideal conditions at 76 gallons per acre, were ethylene dibromide and Iscobrome D.

A comparison of Corynebacterium sepedonicum inocula from resistant and susceptible potato varieties. G. H. STARR AND W. A. RIEDL

Extensive tests were made in Wyoming during 1946 and 1947 to determine the relative pathogenicity of ring-rot inocula from resistant and susceptible potato varieties. Infected tubers of the Bliss Triumph, Red McClure and Teton varieties were used to inoculate healthy tubers of these three varieties and, in addition, the Burbank, which vary extremely in susceptibility to the ring-rot disease. These seed pieces were planted in field plots where the plants were inspected for ring-rot symptoms.

The results showed that both the percentage of ring-rot infection and the severity of infection caused by inocula from susceptible varieties was equal to, if not greater than, that in the resistant varieties.

Microscopic examination of stained slides showed that far more bacteria were present in the Red McClure, Bliss Triumph and Burbank varieties than were present in the Teton variety.

The results of these experiments showed that bacteria infecting the Teton variety and ring-rot-resistant seedlings were not more pathogenic than those infecting the Bliss Triumph,—a susceptible variety.

Some experiences with shell cooled bins for storing seed potatoes. H. O. WERNER

The great variability of temperature in various parts of a bin of potatoes results in similar variability in the initiation and growth of sprouts on tubers. This is more serious with seed potatoes than with table stock. A great advance toward greater uniformity of temperature within the bin was attained by circulating cold air beneath and around the bin (having tight board walls) by using a thermostatically controlled fan which operated only whenever the outdoor air was cooler than that within the bin—with a safety control to prevent operation when potatoes might be frozen. In a bin 16 feet wide, 10 feet deep, that was filled to a height of 7 feet in early October, tubers were kept dormant until mid May when those in the top layer began to sprout. Those in the bottom of the bin remained dormant until the first of June or later. Notable improvements were brought about by dividing the bin into sections 8 feet and later 4 feet wide, (with circulating air spaces in partitions) and by circulating the air continually introducing cold air intermittently by means of a thermostatically operated damper.

Storage and shipping tests with Nebraska Triumph seed potatoes for southern midwinter planting. H. O. WERNER

In order to have western Nebraska-grown Triumph seed potatoes in the proper physical condition to grow promptly when planted in the south in the winter months, large scale tests involving 30 carloads of seed potatoes were conducted to determine the feasibility of accomplishing the early growth of seed potatoes by warming them in storage or in transit or both and planting them in southern Texas and Alabama.

In four weeks the temperature of the center of large bins of seed potatoes was raised one degree F. per day. Uniformity of warming was enhanced by circulating air under, through, and around the bin of potatoes. Such potatoes were beginning to sprout when shipped in mid December. Potatoes loaded out of a cold cellar were effectively warmed in transit. Refrigerator cars equipped with fans, which operated while the car was in motion, equipped with thermostatically controlled alcohol heaters were much more satisfactory for providing uniform warming or warm transit of a carload of potatoes than were the standard refrigerator cars equipped with charcoal heaters. Seed potatoes warmed in storage or enroute sprouted earlier, produced plants earlier in the southern fields and in most seasons produced higher yields of potatoes than those handled in the ordinary manner, *i. e.* stored cold and merely protected against freezing in transit. The effect upon yield depended

largely on the management of the seed potatoes after arrival in the south, *i. e.* whether planted promptly or held for a time, climatic conditions during the growing season, etc.

(A. Lloyd Ryall and J. M. Lutz of the U. S. D. A. Division of fruit and vegetable crops and diseases cooperated with the transit studies and B. S. Pickett and Frank Garret at branch stations in Texas and Alabama respectively cooperated with the field tests.)

The testing of varieties as it applies to a potato improvement program.
E. J. WHEELER

The testing of potato varieties for discoloration and fry matter aids in determining the effectiveness of any cultural experiment for potato improvement. Soaking plugs from tubers in 95 per cent Ethyl alcohol gives a test similar to boiling. The specific gravity measures the degree of mealiness in the tubers. It is possible to run both of these tests on the same tuber and still have the tuber for planting.

A number of samples can be run in the same time it takes to boil one sample. It saves much time in testing parent material for use in a potato breeding program.

The data presented show how the cooking quality of varieties may be improved by earlier planting and frequent irrigation. Also the data on tests with several potato seedlings grown on muck which were tested showed some to be of excellent cooking quality, whereas others were very poor when grown under the same conditions.

SECTIONAL NOTES

ALABAMA

The potato growers in the early commercial area of Alabama will plant nearly 16,000 acres as soon as weather permits. Most of the seed is on hand and some has been cut. The planting will be less than last year despite an increased allotment under support program. The high cost of planting—the highest in many years—is the chief cause of the decrease. However, our trend is to other early crops such as hybrid sweet corn for market.

We have had the coldest spell since 1940 with a period of 13 above zero one morning and several mornings it has been below 20. This cold has continued for more than two weeks with very little sunshine. The land is prepared and ready for the planters, and with a break in the weather our crop could go in within two weeks. It now seems that we will be at least a week late with our planting on the average.

The seed to be planted has been very good in general. There was trouble with field-frost developing rot in approximately 10 cars of

Wisconsin Sebagos and there was frost injury in transit in some cars of seed out of the Red River Valley. Some of our growers let their seed get frozen in storage. We will have about one-third Sebago with the balance Bliss Triumphs.

For the first time, our growers are using fertilizer with approximately a 2 per cent magnesium content. Many are preparing to split the applications of fertilizer to overcome loss due to leaching from heavy floods.

We expect to plant 200 seed source samples and 20,000 index tubers at the Gulf Coast Substation within the next two weeks. (Jan. 31).—Frank E. Garrett.

FLORIDA

Growing conditions have been, in general, favorable for potatoes during the past month, although the heavy rains on the 11th of January caused some damage to recently planted seed, and the cold winds on the 14th of January caused considerable windburn in older plantings.

Late blight is epidemic in tomato fields and has been a constant threat to the potato crop. Growers who have sprayed regularly at 4- to 7-day intervals with Dithane + zinc sulfate have kept the disease under control. Blight has made considerable headway on fields where airplane dusting was resorted to during rainy periods when wet soil made it impossible to adhere to the spray schedule. Blight is also causing considerable damage in the few fields in the area being sprayed with Bordeaux mixture.

In the experimental plots at the Sub-Tropical Experiment Station, Dithane + zinc sulfate have given by far the best control of blight, followed closely by Parzate. All of the copper fungicides, including Bordeaux mixture, Cuprocide, Tribasic copper sulfate, Copper Hydro 40, and Copper A compound, failed to control blight satisfactorily, although nine applications were made. Copper zinc chromate and several other new materials under test likewise failed to control late blight effectively.

The harvesting of the early planted field is underway with yields of 150 to 325 bushels per acre reported by growers. In general, the quality of the crop harvested thus far is good. Little or no late blight tuber rot and little wireworm injury have been found. (Feb. 5).—G. D. Ruehle.

NEBRASKA

In an analysis of the Nebraska potato crop for 1947 and shipments to date, many peculiarities have been noted. As outlined in previous reports during the course of the season, many erratic occurrences, weather

and otherwise, have influenced production. Briefly summarizing, production on the dry land areas was about one-half of normal, and from one-fourth to one-third reduced under irrigation. Because of adverse conditions of growth at harvest time, higher grade-outs than usual have been experienced. Two factors have been especially severe, one, high mechanical injury; and the other, more scab infection than is usual.

Despite the adverse factors, prices received by growers to date have been higher than competing areas for much of the shipping season. U. S. No. 1 Table Stock has been at a high level until quite recently. Most dealers have reported a slump for the past two weeks, but expect the prices to recover shortly. Because of the high price being received for the first quality pack, shippers have experienced an unusual demand for lower grade potatoes. In other words, the demand from many sections has been influenced in its preference for lower grades because of the high prices obtained for the best quality. This has been a good situation, because of the fact that the higher percentage of the lower grades is in existence in the territory.

The high prices received for table stock have unduly influenced the certified seed market. Ordinarily, certified seed from the territory sells at a premium above table stock, but this year table stock premiums are so great, that certified seed is frequently sold at a disadvantage. In many cases, certified seed stock is being diverted into table stock channels, because of the price situation.

It is much too early to make any estimate on the crop plantings for next year. We feel, however, that the high prices being obtained will have a depressing effect on our acreage during 1948. (Jan. 29).—MARX KOEHNKE.

NEW JERSEY

Some New Jersey potato growers are already cutting their seed potatoes for the planting of their early crop. However, there are anywhere from 6 inches to 3 feet of snow on the ground. Our temperatures have been several degrees below normal most of the time since the first of January, but there is very little frost in the ground because of the snow cover. Soon after the snow melts, growers will most likely be able to prepare the soil for planting unless the exceptionally cold weather prevails after the snow disappears. Some growers generally start to plant about the 17th of March, but it doesn't look much like planting now.

The potato acreage goals have been reduced approximately 5 per cent from those allotted in 1947, but if growers keep within the acreage allotments set up by the State P & MA the actual planted acreage will be only slightly below last year's acreage since many growers did not

plant the total acreage allotted last season. However, this cut is causing some growers concern since their acreage will be reduced below that most economical to handle. Seed, fertilizer and labor costs are higher than last year and every precaution must be taken to keep down the costs of production if a profit is to be realized. (Feb. 11).—J. C. CAMPBELL.

NEW YORK

Sub-zero temperatures during the latter half of January have helped the local potato market. Car shipments from out-of-state points have shown enough frost damage to create a great demand for local fresh, graded, and delivered potatoes.

Our out-of-state car shipment is very light. Movement by trucks, bringing citrus fruits and fresh vegetables from the south, is getting to be more of a factor. Prices on a 100-pound basis were running from $3.20 to $3.35 per hundred on the 2d of February. Pecks are selling at $.51 to $.52 at the farm.

Our seed demand is very good with many orders being filed for spring shipment. The movement is slow at the present time, because of weather conditions which have seldom been equalled. (Feb. 21).—H. J. EVANS.

SOUTH DAKOTA

Grading and shipping of certified potatoes has been delayed in South Dakota because of the extremely cold weather and blocked railroads. Clark, one of the principal shipping points, did not have rail service for three weeks because of snow-bound tracks. Bliss Triumphs are now being loaded, but the market has been very slow. A number of cars of table stock have gone to the government at the support price of $2.75 for U. S. No. 1 quality.

New foundation seed is now arriving for storage for the spring planting. Present indications are for an acreage about the same as last year when 6,350 acres were entered for certification from a state acreage of 23,000.

David Giese, head field and car inspector, resigned on the 3d of January because of ill health. No field inspector has been appointed at this writing, but applications will be considered by the directors at their next meeting. The annual meeting of the South Dakota Potato Growers' Association has been set for the 18th of March at Watertown, and Marx Koehnke, certification manager for the Nebraska Potato Growers, will be the main speaker. (Feb. 3).—JOHN NOONAN.

TEXAS

Continued cold weather has caused delayed emergence, but we do not think this will result in any decreased yield. None of the crop has been damaged by frost, although the early plantings are now six (6) inches or more high. During the past three days we have received very beneficial rains. The ground is in the very best of condition and prospects at this time are for a better crop than normal. (Jan. 27).—CLEVE H. TANDY.

AMERICAN POTATO YEARBOOK

A reference book covering the potato field is scheduled for publication about the 1st of May. The volume will be known as the American Potato Yearbook and will contain important factual and statistical information about the potato industry. The editor of the Yearbook is John C. Campbell, Assistant Research Specialist of the Rutgers University College of Agriculture and the New Jersey Agricultural Experiment Station at New Brunswick. C. S. Macfarland, Jr., Advertising Manager of the American Potato Journal for the past six years, is Business Manager.

The book will be pocket size. Some of the editorial contents will include a list of all Potato Associations and certification authorities, data on Potato Service organizations and a list of important publications in the potato field. There will also be statistical information of importance. Such information will include a tabulation by states of both seed and table stock production and stocks on hand as of January 1, 1948. There will also be statistics on the Canadian potato industry, articles on world production of potatoes and major potato diseases. A special feature will be a classified directory of business concerns serving the potato field.

The Yearbook will be sent free upon publication to all members of the Potato Association of America. It will be available to non-members at $1.50 pre-publication and $2.00 post-publication. Orders should be sent to the American Potato Yearbook, Business Office, 289 Fourth Avenue, New York 10, N. Y.

ERRATUM

In Volume 24, No. 11, in the article "Protection of the Property of the Potato Breeder in the Netherlands" by Dr. H. de Haan, p. 376, lines 3 and 4 should read "For potatoes the levy is f 0.03 (In United States money slightly more than one cent), f. 1.— = 0.38 *per 100 kg.* instead of *per kg.* certified seed potatoes."

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BACTERIAL RING ROT OF POTATOES[1]

Present status of this disease compiled by

BERNARD BARIBEAU[2]

Ste. Anne de la Pocatiere, Province of Quebec, Canada

Previous to 1931 bacterial ring rot of potatoes was unknown on this continent. Since then the disease has brought alarming losses to the merchant because ring-rotted tubers cause a storage rot; to the table-stock grower because the rot in the field decreases the yield; to the certified seed grower because the presence of even one ring rot plant or tuber disqualifies a field from certification and the attendant premium in price.

NAME—Some confusion has apparently arisen in the literature from the use of different terms and classification of this new and highly infectious disease.

Appel (1906) published a description of a potato disease which he called "bacterial ring disease." Spieckermann (1913) established the common name "Bacterienringfäule" for this disease in Europe. In Canada, Baribeau (1931) referred to a new potato disease as "Bacterial Wilt" and in later reports (1935) used the name "Flétrissure Bactérienne" and in (1937) "Flétrissure Bactérienne et Pourriture Molle." Savile and Racicot (1937) suggested that the disease be known by the popular name "Bacterial Wilt and Rot." Bonde (1937) described a new disease of potatoes in Maine which he called "Bacterial Wilt and Soft

[1]Contribution No. 64—Division of Plant Protection, Science Service, Dominion Department of Agriculture, Ottawa.
[2]District Inspector in charge Seed Potato Certification Office.

Rot." In France, Lansade (1942) reports that this disease is known as "Flétrissement Bactérien."

HISTORY—The first record of the disease is from Germany where it was described by Appel (1906). It has been reported present in the province of Quebec by Baribeau (1931) and since 1931 this disease has been found in all Canadian provinces. Jorstad (1932) observed it in Norway, and Lansade, in France, reports that "le flétrissement bactérien" was observed in 1934, but probably this malady has long been confounded with "Verticilliose." According to Bonde (1937) the disease was present in Maine in 1932, and data recorded by Metzger show that it was prevalent in Colorado in 1938. Brentzel reported that the disease had reached North Dakota by 1939. Belova noted it in Russia in 1940. In 1939, in the United States, the disease had been reported definitely from 27 states, and at the present time, from 45.

CLASSIFICATION—Spieckermann and Kotthoff (1914) fully described the organism and first used the name *"Bacterium sepedonicum."* Jensen (1934) suggested that the bacterium causing ring rot of potatoes should be classified as a *Corynebacterium*. Magrou (1937) placed the pathogen in the genus *Phytomonas* and this only three months previous to Savile and Racicot (1937). For the sake of uniformity and to avoid confusion it was recommended at a meeting held at Columbus, Ohio, in December 1939, that the common name "Ring Rot" be adopted and in French "Pourriture Bactérienne du Cerne" for the potato disease caused by *"Phytomonas sepedonica."* Finally, Skaptason and Burkholder, (1942) with evidence at hand proposed to place the organism in the genus Corynebacterium. Therefore the pathogen responsible for this disease would be known as *"Corynebacterium sepedonicum.* (Spieck. and Kott.) Skap. and Burk.

ECONOMIC IMPORTANCE—Bacterial ring rot is of great economic importance and one of the most serious diseases of the potato not only in this country but throughout North America and Europe. The highly infectious nature of the disease and the extensive interprovincial and international movement of potatoes and potato containers create a potential menace to the potato industry.

Nature of Loss from This Disease: 1—There is a reduction in yield because of the rotting of tubers in the field. This may vary from one rotted potato to 75 per cent. Therefore, in the fall, dealers hesitate to purchase potatoes from supposedly infected districts, fearing loss through rot. 2—Storing of potatoes from badly affected fields may result in considerable decay and breakdown because of complications from secondary organisms as well as contaminations of premises. 3—The breaking down of tubers in sacks and containers in transit may

necessitate the added expense of regrading, repacking and disinfecting of bags, graders and storages. 4—Growers of certified seed suffer not only from reduced yield, but also from reduced market prices as well as loss of customers resulting from the failure of their fields to receive certification.

Baribeau (1935) has shown that this disease was present in 43 per cent of the commercial potato fields in thirty counties of the province of Quebec and the loss caused to the crop by soft rot varied from 20 to 45 per cent. In 1944, 15.7 per cent of the potatoes that had passed certification for other diseases were rejected because of bacterial ring rot and in 1945, the rejections caused by ring rot were 8.6 per cent. In 1946, a survey of 378 fields planted with table stock revealed that 74.6 per cent of the fields were found to be affected with bacterial ring rot. At digging time, 7 per cent of the tubers from these affected fields were showing rot. Bonde (1939) claims that certified seed growers in Aroostook county, Maine, sustained a loss of $32,000 in 1937 and $80,000 in 1938. In 1937, 11 per cent of the potatoes that had passed certification were rejected because of ring rot and in 1940, 7.5. Eddins (1938) states that the loss from the disease at Hastings, Florida, was 5 per cent in 1937 and that this was reduced to 0.5 per cent in 1939 when strict attention was paid to the source of seed. Statements like those of Leach and others (1940) are observed in the literature. "The estimated loss in one county is from 500 to 700 cars plus reduced prices on several thousand cars." "Ring Rot is of a major importance. The loss in 1939 was probably $250,000." In France, during the years 1934 to 1938, bacterial wilt showed as high as 20 to 30 per cent infection of the plants in the most severely affected fields.

SYMPTOMS—Yellowing, wilting and drooping of the leaflets are usually not observed until late in the season. Affected leaflets initially develop a mild chlorotic appearance which progresses through a pale green stage to a yellow. This sequence of symptoms usually starts with the lower leaves of the plant, this continues rapidly until the plant wilts and eventually dies. In France, the second year symptoms are described under the French name of "nanisme, rosette, court-noué," which names are more apparent on the two middle stalks. These symptoms of "nanisme" have not been observed on this continent. (Fig. 1.) Tuber symptoms may vary from that of no apparent infection to that of complete disintegration. The decay begins in the region of the vascular ring of the tuber. It may affect any part of the ring or the entire ring, in the latter case causing a ring rot appearance, the tuber shows a yellowish discoloration in the region of the vascular ring which contains innumerable ring rot bacteria. This decayed material may be forced out from the infected vascular ring if the tuber is squeezed in the hand.

FIGURE 1—Plant from a diseased set on which the discoloration of the vascular ring is very apparent as illustrated above.—Note the dwarfing of the two middle stalks and the newly formed tubers already affected by this typical rot. This illustrates second year symptoms of bacterial ring rot, such a progeny disappears within two or three years. (Photo. courtesy of Messrs. P. Limasset and A. Lansade, Versailles, France.)

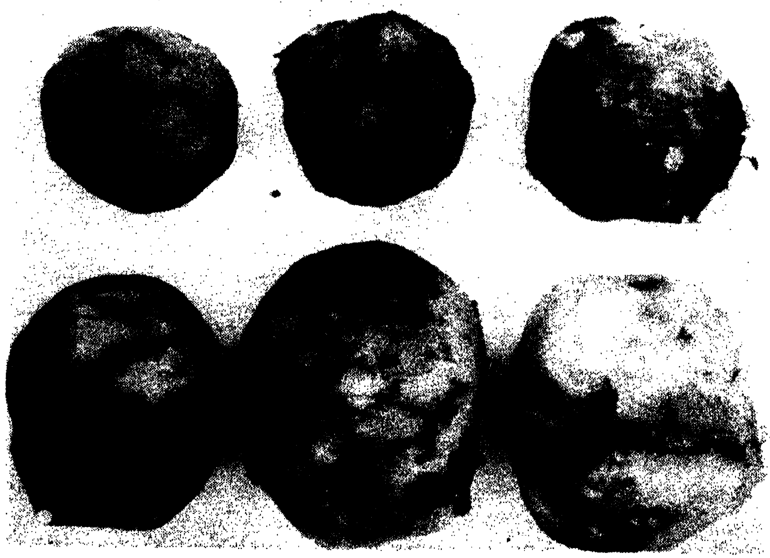

FIGURE 2—Tubers showing external symptoms of bacterial ring rot. Typical cracking in the Green Mountain variety. (Photo 1936 B. Baribean).

OVERWINTERING—The pathogene overwinters in the tubers. To date, there is no proof that the pathogen can live over winter in the soil or in the remains of diseased potatoes. The tubers may carry the bacteria without showing any signs and therefore it is impossible to select disease-free seed from an infected crop. The bacteria may also remain viable from September to May on a dry surface of metal stored in unheated field barn, as well as for many months on bags and bin walls.

SPREAD—The pathogene may be disseminated by infected tubers and from them, by cutting knives, planters, bags, etc. The bacteria from the decayed tubers, when smeared on the surface of healthy tubers, may remain alive all winter in the dry state, and infect the sets when the tuber is cut and planted. Ring rot is so infectious that a cutting knife drawn through a diseased tuber can transmit the disease to the next twenty-five healthy tubers. Because of this marked infectivity, ring rot may increase from a trace in one season to as much as 60 per cent in the next. In France, the disease is transmitted from year to year by the mother tuber, but such a progeny disappears in two or three years.

CONTROL—Ring rot is a highly infectious disease but its control is entirely possible by the use of disease-free seed (certified), disinfection of warehouse, cellars, tools, planters, diggers and graders, and by the use of new or disinfected bags. Whole seed is recommended in preference to cut seed for planting. Most of the provincial governments have enacted legislation for the control of ring rot disease. In addition, certain sanitary measures must be carried out by all those planting and handling potatoes.

For the disinfection of storages, cellars, bins, warehouses, etc., spray with a solution containing 2 lbs. blue stone in 10 gal. of water, or 1 pint of formalin (formaldehyde) in 25 gal. of water, or 2 per cent Lysol. For tools, machines, planters, graders, barrels, crates, baskets, etc., spray with a solution containing 1 pint of formalin in 25 gal. of water or for machinery, using 3 teaspoonfuls of Lysol to a gallon of water. For sacks (bags), gloves, etc., soak for 2 hours in a solution containing 1 pint of formalin in 25 gal. of water. For cutting knives, a good disinfecting solution may be made by dissolving 2 corrosive sublimate tablets in 1 pint of water, (making a 1-500 solution or 1 ounce to 3½ gal. of water,) or use a Lysol solution, 3 teaspoonfuls to one gallon of water.

RESISTANCE TO RING ROT—No varieties are immune to this disease but the "Teton" has shown a high degree of resistance to

ring rot over a period of years in Wyoming and Maine. In France, the "Furore" variety has never shown any trace of infection.

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PROMISING NEW CHEMICALS FOR THE CONTROL OF DISEASES AND INSECTS

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This discussion includes the results of two separate experiments both conducted with the Katahdin variety. The first part of the discussion will deal with the comparison of six fungicides in the National Cooperative Potato Spray Fungicide Experiment whereas the second part deals with an experiment in which seven insecticides and two fungicides were compared.

The fungicide experiment contained the following treatments to all of which 1.5 pounds of 50 per cent wettable DDT were added for each 100 gallons.

TABLE 1.—*Potato spray fungicide experiment*

Treatment	Total Yield Bus. per Acre	Total Insect Population 520 Sweeps		
		Flea Beetle	Leafhopper	Aphid
1. Check, DDT 1½—100	403.5	1049	34	3619
2. Check, Bordeaux 8-8-100	404.7	118.3	25	3341
3. Dithane D14 2 qts.—100	464.2	1326	59	3046
4. Zerlate 2-100	431.2	918	28	3376
5. Phygon 1-100	404.2	1509	50	2999
6. C-O-C-S 4-100	385.0	1385	48	2843
7. Parzate 2-100	435.5	1294	36	2964
*8. Tri-Basic Copper 4-100	449.7	1438	58	3125
L. S. D. at 5%=33.1 bus. per acre				

*Randomized with adjoining experiment but can logically be compared with other fungicides.

Eight applications were made, starting on the 19th of June and ending the 11th of August. A four-row power driven sprayer equipped with three nozzles per row and delivering 125 gallons per acre at 300 pounds pressure, was used.

Disease counts were made on ten plants in two of the four replicates on the 1st of August and again on the 12th. Only .5 of 1 per cent of the leaves in the no-fungicide check plots were infected with late blight on each date and no early blight was noted. Not a single plant was found with more than 2 per cent of its foliage infected.

Insect sweepings were taken thirteen times from ten places in each of the four replicates making a total of 520 sweepings from each treatment. The total number of flea beetles, leafhoppers and aphids for each treatment was quite similar for the various treatments in the fungicide test. However, it is interesting to note in table 1 that the flea beetle population was somewhat lower on the plots sprayed with Zerlate + DDT than on any other treatment, whereas flea beetles were noticeably more plentiful on plots sprayed with Phygon + DDT. Possibly Zerlate

has some insecticidal value against flea beetles. The population of leafhoppers and aphids did not follow this same trend.

The experiment was harvested on the 29th and 30th of September and total yields were secured from 1/40 of an acre in each replicate. Plots sprayed with Dithane D14, + Zinc Sulfate and lime + DDT produced an average yield of 464.2 bushels per acre, a significantly higher average than was produced by any of the other treatments with the exception of Zerlate and Parzate which produced 431.2 and 433.5 bushels per acre, respectively.

An analysis of variance indicates that a difference of 33.1 bushels per acre are required for significance at the 5 per cent point. Plots sprayed with Parzate and Zerlate produced significantly higher yields than did plots sprayed by C-O-C-S, whereas plots sprayed with DDT alone, Bordeaux or Phygon produced intermediate yields of 403.5 and 404.2 and 404.7 bushels per acre, respectively. C-O-C-S sprayed plots produced the lowest average yield of 385.0 bushels per acre. However this yield was not significantly lower than the plots sprayed with Bordeaux, Phygon or DDT alone. The increases in yield over the other treatments produced by the plots sprayed with Dithane D14 were obviously not due to either disease or insect control since the incidence of disease and insects found on these plots was as great as on those sprayed with Bordeaux + DDT or DDT alone. Therefore we are not in a position to state the reason for this increased yield, however it may be due to stimulation.

In the same field and in an area of equal size and adjacent to this test we conducted another experiment to compare the value of several insecticides when used in combination with 8-8-100 Bordeaux. However, one series of plots was sprayed with Tri-Basic copper 4 lbs. to 100 plus 1½ lbs. of DDT as used in the National Fungicide Test. This series produced an average yield of 449.7 bushels per acre. This yield is significantly higher than the yields produced by plots sprayed with DDT alone, Bordeaux, Phygon or C-O-C-S, was slightly greater than those sprayed with Zerlate or Parzate and approaches the yield of the plots sprayed with Dithane D14. Since this treatment was randomized with a Bordeaux-DDT check which produced a yield similar to the Bordeaux check in the National Fungicide test it is believed that we are justified in comparing the Tri-Basic copper plots with the treatments in the fungicide test.

In the experiment set up to evaluate the effectiveness of certain insecticides the following treatments were used.

As mentioned before, this experiment was located in the field with the fungicide experiment and was sprayed on the same dates with the same equipment. Disease counts were taken here also and in no case

did we find more than 2 per cent of the leaves of any plant infected and less than 1 per cent was found on the average. Insect sweepings were taken thirteen times as in the other test and the total population for the five hundred and twenty sweepings is recorded with the yields in table 2.

Plots sprayed with Bordeaux + Parathion produced the highest yield, namely 462.0 bushels per acre, and gave by far the best control of aphids but only fair control of leafhoppers and relatively poor control of flea beetles. This yield was significantly higher than that produced by plots sprayed with Chlordane, Rhothane or Toxaphene and is within .6 of a bushel of being significantly better than those sprayed with 2 pounds of 50 per cent wettable DDT. A difference of 39.6 bushels per acre are required for significance at the 5 per cent point. Bordeaux plus 2 pounds of Toxaphene caused very noticeable injury to the plants resulting in a loss of chlorophyll and curling of the leaves. It also gave poor control of aphids and leafhoppers and only fair control of flea beetles. At the first application 4 pounds of 25 per cent Toxaphene were used per 100 gallons of water but the injury was so severe that 2 pounds were used in all subsequent applications. However even this concentration caused injury and the average yield was only 344 bushels per acre,

TABLE 2.—*Potato spray insecticide experiment*

Treatment	Total Yield Bus. per Acre	Total Insect Population 520 Sweeps		
		Flea Beetle	Leafhopper	Aphid
8. Tri-Basic Copper 4-100 + 1½# 50% DDT	449.7	1438	58	3125
9. Bordeaux 8-8-100 + 2# 25% BHC	450.7	1933	122	1327
10. Bordeaux 8-8-100 + 2# 15% Parathion (3422)	462.0	2441	88	190
11. Bordeaux 8-8-100 + 2# 50% Chlordane	404.5	1624	98	3230
12. Bordeaux 8-8-100 + 2# 25% Toxaphene	344.0	1653	176	2908
13. Bordeaux 8-8-100 + 2# 50% Rhothane	402.5	2091	58	2204
14. Bordeaux 8-8-100 + 1 qt. 25% DDT Emulsion	428.7	1288	53	455
15. Bordeaux 8-8-100 + 2# 50% DDT	423.0	914	59	1386
*2. Check, Bordeaux + 1½% 50% DDT	404.7	1049	34	3619
L. S. D. at 50% = 39.6 bus. per Acre				

*Part of fungicide test shown here for comparison of insect control between 1½ lbs and 2 lbs. of DDT per 100 gallons of spray.

significantly less than that produced by any other treatment. Plots sprayed with Bordeaux + BHC or Tri-Basic Copper + 1½ pounds DDT produced much higher yields than did those sprayed with Bordeaux plus Chlordane, Toxaphene or Rhothane. Bordeaux + BHC or wettable DDT gave fair control of aphids but DDT was superior to BHC in the control of leafhoppers and flea beetles. There was practically no difference in yield between the plots sprayed with DDT emulsion and 50 per cent wettable DDT. Although there were three times as many aphids on the plots sprayed with wettable DDT as on those sprayed with DDT emulsion, it is also interesting to note that increasing the rate of DDT from 1½ pounds to 2 pounds per 100 gallons resulted in slightly better control of flea beetles and much better control of aphids, but made no difference in the control of leafhoppers. The best control of flea beetles was obtained with 2 pounds of DDT.

Conclusion

The use of Dithane D14 + Zinc Sulfate and lime resulted in the highest yield, although not significantly higher than Zerlate, Parzate or Tri-Basic copper. Plots sprayed with C-O-C-S returned the lowest yield but not significantly lower than the yields from plots sprayed with Bordeaux, Phygon or DDT alone. Differences were not due to disease control since so little disease was present on the check.

Among the insecticides under test Parathion (3422) was outstanding in its control of aphids and resulted in the highest yield. Plots sprayed with BHC, DDT emulsion and wettable DDT were similar in yield and these yields were not significantly lower than the yield produced by the use of Parathion. DDT emulsion gave better control of aphids than DDT powder whereas DDT powder gave best control of flea beetles. Toxaphene caused severe plant injury and resulted in poor insect control.

THE EFFECT OF DIFFERENT RATES OF APPLICATION OF 2, 4-D ON THE YIELD OF POTATOES

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Introduction

The control of weeds in potato fields on muck soil has always been a problem and frequently is responsible for a major portion of the cost of producing a crop. Due to the present cost of labor necessary for hand weeding, this experiment was conducted to ascertain the possibility of including a chemical weed killer such as 2, 4-dichlorophenoxyacetic acid commonly called 2, 4-D, in regular potato spray mixture.

Materials and Methods

The Katahdin variety of potatoes was planted on the 12th of June in rows three feet apart. The hills were spaced twelve inches apart in the row. A sodium salt of 2, 4-D containing 70 per cent dichlorophenoxyacetic acid was used as the weed killer. Four rates of application of 2, 4-D were incorporated into the potato spray, which consisted of four pounds of Basi-cop and one and one-half pounds of 50 per cent DDT per one hundred gallons. A treatment coontaining no chemical weed control served as the check treatment. The amounts of 2, 4-D applied started with one-quarter pound of 70 per cent sodium salt per one hundred gallons of spray and increased in quarter pound increments up to and including one pound per one hundred gallons. The spray was applied at the rate of approximately one hundred twenty-five gallons per acre, thus making the amounts of 2, 4-dichlorophenoxyacetic acid applied on a per acre basis .218, .437, .655, and .875 pounds respectively.

Observations and Results

The first application of 2, 4-D was incorporated in the regular potato spray applied on the 15th of July, thirty-three days after planting. Two days after the application, considerable distortion of the potato vines was observed on the .875 pounds per acre rate, and a slight amount of distortion on the .655 pound rate. The vines recovered from this distorted condition after a few days. The .218 and .437 pound rates created no distortion of the vines. The .655 and .875-pound rates resulted in satisfactory control of all broad leaf weeds. Smart weed comprised a majority of the broad leaf weeds present. The 437-pound rate caused some weed distortion but was not sufficiently strong to completely kill the weeds. The .218-pound rate yielded no visible results.

Observations made during the week of the 11th of August, revealed

that blossoming was inhibited by applications of 2, 4-D. The check plots which had received no 2, 4-D bloomed profusely. The amount of bloom decreased as the amounts of 2, 4-D in the treatments increased. Only a few blossoms were observed on the plants which received the .655-pound per acre application, and no blooms were present on the plants which had been sprayed with .875-pound of the 2, 4-dichlorophenoxyacetic acid per acre. These applications were made before the plants had bloomed. Ennis, *et al.* (1) reported increased fruit setting from applications of 2, 4-D made at time of blossoming.

The second application of 2,4-D was included in the potato spray applied on the 20th of August. Weed control effects were similar to those occurring after the first application. After the second application the potato vines receiving the one pound rate did not seem to undergo as severe distortion as that observed as a result of the first application.

Killing frosts occurred on the 22d of September. On the 24th of October, twenty hill samples were dug by hand from each plot. The weights of No. 1 size tubers were recorded and the yields calculated on the basis of one hundred-pound bags per acre. The data are presented in table 1.

TABLE 1.—*Yields of potatoes from plots which had been treated with various amounts of 2, 4-D incorporated in the regular spray.*

Treatment	Replications			Total Yield	Average Yield	Yield 100 Lbs. Bags Per Acre
	I	II	III			
Spray, No. 2, 4-D	*23.8	*23.1	*17.4	64.3	*21.4	155.3
Spray ¼# 2, 4-D/100 gal.	21.6	20.3	22.1	64.0	21.3	154.6
Spray ½# 2, 4-D/100 gal.	23.8	18.7	19.9	62.4	20.8	151.0
Spray ¾# 2, 4-D/100 gal.	17.1	18.9	20.4	56.4	18.8	136.4
Spray 1# 2, 4-D/100 gal.	21.8	17.5	23.7	63.0	21.0	152.4

*Yield in pounds from 20 hills.

The yields for all plots were below normal caused by late planting and a prolonged drought period during the summer. The difference in yields between extremes on a per acre basis was only eighteen and nine-tenths bags. The differences in yields between treatments were not found to be significant. Weed competition was not an influential factor in the yields since all weeds from check plots and remaining weeds in treated plots were removed by hand.

The yields from this experiment are in line with the findings of Ennis, W. B. *et al.* (1) in which they studied the effects of various growth-regulating compounds on Irish potatoes. In their work the

growth-regulating compounds were not incorporated in the potato spray mixture. They observed however, that 2, 4-dichlorophenoxyacetic acid applied in aqueous solution had no detrimental effect on top growth or tuber yield.

CONCLUSIONS

These results indicate that control of weeds in potato fields may be possible by incorporating a weed killer with the regular potato spray mixture. Applications of as much as .875 pounds per acre of 2, 4-dichlorophenoxyacetic acid applied in the form of the 70 per cent sodium salt resulted in control of weeds and no significant decrease in yield of Katahdin variety potatoes.

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THREE NEW VARIETIES OF IRISH POTATOES

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Since 1935 the Louisiana Agricultural Experiment Station has been conducting a breeding program with Irish potatoes with the following purposes in view: Breed varieties having a greater adaptability to the short days of the south, resistance to mild and rugose mosaic and other factors which make for general adaptability such as keeping quality and market preference. In this work it has been kept in mind that new varieties must not only produce well in Louisiana but they should also produce satisfactorily in northern seed-producing areas. The more promising seedlings therefore have been tested not only in the south but also in the north.

Since the program began, more than 100,000 seedlings have been grown and tested. Of these only three seedlings have been selected as outstanding and worthy of introduction. Two are red varieties and one is white. The first red variety to be named is DeSota and the second one is LaSoda. Both of these varieties are the result of crosses between Triumph and Katahdin. Th white variety, LaSalle, is a cross between Chippewa and an inbred line of the Triumph. LaSalle and DeSota were named after two early Mississippi Valley explorers. Since only a beginning has been made in exploring the possibility of potato breeding these names seemed appropriate. The LaSoda was named after Louisiana

[1]Cooperating with the U. S. Department of Agriculture.

and South Dakota. The growers and potato organizations of South Dakota, in the cooperative tests with the Louisiana Station, became impressed with the performance of LaSoda, formerly called L 36, that they requested the new variety to be named after the two states. A brief description of the three new varieties follows:

DeSota

The De Sota is a cross between the Triumph and Katahdin and was first grown as a seedling in the fall of 1938. The plants are vigorous and upright in habit, with leaves that are very small and similar to those of the Triumph. It blooms freely and the flowers are purple. The tubers are round to slightly oblong and the color of the skins varies from red to pinkish red. The eyes vary from a medium depth to shallow. This variety is medium early in maturity. It is resistant to mild mosaic.

LaSoda

The LaSoda is a cross between the Triumph and Katahdin and was first grown in the fall of 1936. The plant is of medium vigor and very upright with medium to small leaves. It blooms more freely than the Triumph and the flowers are purple. Its tubers vary from semi-round to slightly oblong, similar to those of the Katahdin, the color of which is a very bright pinkish red, and the skin is very smooth. The eyes are medium in depth to very shallow. This variety is early to medium early. Even though it shows some resistance to mosaic it is not in any way immune.

LaSalle

The LaSalle is a cross between the Chippewa and an imbred seedling of the Triumph. It was first grown as a seedling in the fall of 1936. The plants are medium in vigor and very upright in habit. The flowers are white. The tubers are semi-flat and slightly oblong and the skin is white, with shallow eyes well distributed over the tuber. This variety is medium early and is very resistant to mild mosaic.

In table 1 the yields of the three Louisiana varieties are given and these are compared with the Triumph, which was used as a standard, as Triumph is the principal variety grown in Louisiana. The seed are from three different sources,—namely, (1) Lousiana spring, seed which was harvested in the spring and held in cold storage at 40° F. from the 15th of June to the 15th of January and removed for planting; (2) seed grown in the northern areas, and (3) seed grown in the fall in Louisiana and harvested on the 25th of November and stored at 80° F. to hasten the rest period until the time of planting. Comparable lots of Triumph were used.

It will be noted, in table 1, that in every instance each of the three new varieties significantly outyielded the Triumph, and that northern and Louisiana spring-grown seed significantly outyielded Louisiana spring-grown seed.

TABLE 1.—*Yield (Bushels per acre of marketable potatoes) and source of seed test of three new Louisiana Irish potatoes.*

Variety	Source of Seed			Variety[1] Average
	Louisiana Spring	Northern	Louisiana Fall	
Triumph	87	163	152	134.0
De Sota	115	224	205	181.3
LaSoda	96	254	189	179.7
LaSalle	121	216	223	186.7
Source of Seed[2] Average	104.8	214.3	192.3	

[1]Difference necessary for significance—23.20 bus.
[2]Difference necessary for significance—20.08 bus.

It is with hesitation that two red varieties have been released but each has a contribution that cannot be overlooked. The DeSota is resistant to mosaic whereas Triumph is very susceptible. It is felt that that reason alone warrants its release, but it has produced higher yields in Louisiana than the Triumph. As for the appearance of the potato on the market it is very difficult to tell the difference between the DeSota and Triumph. The LaSoda although not mosaic resistant produces higher yields than the Triumph and the potato has a bright red velvet appearance which attracts the consumer appeal so much that this variety when placed on the market has sold at 15 to 25 cents per hundred premium compared with other varieties. This fact alone cannot be overlooked. The LaSalle, a white variety, also produced much higher yields than the Triumph and in maturity is similar to that of the Cobbler. It is believed by many who have tested this variety that it might replace the Cobbler in many areas. The tubers are much smoother than the Cobbler and the plant is very resistant to mild mosaic. It has been grown continuously in Louisiana for twelve years and to date no plant has been found to be affected with mild or rugose mosaic, even when grown side by side with inoculated plants, over a period of years. These varieties, like all others must be grown in various areas, and if they perform as well in other areas as they have in Louisiana they will continue to be increased. Four seed potato-producing areas are now increasing these varieties for distribution and a limited amount of seed is now available.

SECTIONAL NOTES

ALABAMA

Potatoes in the commercial-producing section of Alabama are emerging seemingly all at once. After a very cold, wet and otherwise backward January, from the 4th of February until the 2nd of March the weather has been ideal for starting our crop. The bulk of 16,000 acres was planted within a period of less than 10 days and indications point to a very good stand, in general. An increasing number of our producers are side-dressing at this time with approximately 600 pounds of additional 4-10-7 in an effort to increase yields and especially the percentage of No. 1 size tubers on light soils.

The chief worry at this time is the danger of a killing frost and growers are covering the young plants as deep as they can to retard their growth. Faith, the very important factor in such an expensive early truck crop, springs eternal in the heart, and our growers have demonstrated that they perhaps have more than their share. The Sebago is favored here because they have a greater comeback after frost because of their longer life period of growth.

All in all our Alabama prospects are very good for this time of year.—FRANK E. GARRET.

FLORIDA

Approximately 25 per cent of the acreage is harvested in the Dade County section. Many of the growers are using Sinox to kill the tops a week to 10 days prior to harvesting, a practice which reduces cracking of the tubers as they drop to the ground from the digger. Early plantings have yielded well and the quality of the crop thus far has been the best in several seasons.

Late blight is under control in later plantings, but aphids and serpentine leaf miners are causing damage, and insecticides are being added to the Dithane-zinc sulfate spray for their control. Dr. D. O. Wolfenbarger, Entomologist at the Sub-Tropical Experiment Station, reports that the new insecticide Parathion is giving the best control of aphids and leaf miners in his test plots of various materials used, including DDT emulsion, Chlordane, Isotox, Vapotone, chlorinated camphene, and calcium arsenate plus nicotine sulfate. Some growers are using Isotox (high gamma-isomer benzene hexachloride) but are limiting treatment to one application to avoid taste contamination in the tubers.

The fungicide test plots at the Sub-Tropical Experiment Station were harvested the 25th of February. The following average yields in bushels per acre, Bliss Triumph potatoes, from the different treatments

were as follows: Checks, 93; Dithane-zinc sulfate, 269; Parzate, 249; alternating Cuprocide and Dithane-zinc sulfate, 235; Z-78 (carried over from last year), 217; tribasic copper sulfate, 215; copper-hydro 40, 210; Cuprocide, 207; bordeaux mixture 4-2-50, 201; Copper-A compound, 199; copper-zinc chromate, 182; experimental fungicide HL-275, 154; and experimental fungicide G. Ch. 629-308, 137. The yields obtained were closely comparable to the degree of control of late blight obtained with the various fungicides, which were applied at the same rate and the same nozzle setting at each application for a total of 10 applications during the season.—GEO. D. RUEHLE.

MAINE

The Experiment Station is making a study to determine if there is any increase in the amount of net necrosis, stem-end browning or general discoloration of tubers in transit. Dr. Folsom of the Experiment Station is supervising this study. He is taking samples of several cars as they are being loaded. He will sample these same cars on their arrival in New York. It is expected that his results will be available soon.

Farmers have received the results from their Florida tests and they are outstandingly good. This year only sixteen of the 300 lots of Chippewas had Florida readings of more than 5 per cent disease. None was above the 20 per cent which is the maximum allowed for certification. Approximately 2800 posters have been distributed in the interest of the campaign to plant Blue Tag Certified Seed throughout Maine.

The industry is holding a discussion on a proposed Marketing Agreement which has been drawn up by representatives of the industry. These meetings are being held previous to the formal hearing which has been requested.

A program has also been drawn up by the industry which has not only been presented at the meetings but is being generally approved by the farmers.

Every one in the state is gratified to know that Dick Newdick was selected to go to Europe with Al Mercker. Dick deserves such a trip if any one does and he certainly knows the potato situation from A to Z. He was presented a purse of $1,000 from the seed growers of Maine as an expression of appreciation and as a "going away" present. We are looking forward with interest to his return and to hear his reports of the potato situation in Europe.

The following program was adopted by the Potato Committee at a statewide Production and Marketing Conference. This Committee was composed of State and County P. & M. A. Committeemen, representa-

tives of Maine Agricultural Extension Service, Maine State Department of Agriculture, and potato industry leaders, and adopted resolutions that:

1. A permanent price support program be maintained at a level which will prevent disaster.

2. Potato growers recognize the economic aspects of over-production and recommend the continuation of federal potato acreage allotments.

3. The industry take steps immediately to help itself and to improve the quality of its product for the consumer:

(a) by means of a marketing agreement or similar instrument
(b) by encouraging the increased use of consumer packaging
(c) to mark all containers as to grade and size,—properly and prominently
(d) by revision of federal grading laws to restrict tolerances to bring about uniformity in size as well as quality
(e) by aggressively pursuing through the facilities of the Research and Marketing Act of 1946 and any other means, the development of new and better uses for potato by-products.

4. Until such time as the industry itself can completely handle its off-grade potatoes withheld from market that the federal Government assist by means of diversion programs.

5. The industry develop a better feeling towards itself in the eyes of the consuming public by means of the publication of true and undistorted facts and figures.

6. A committee of a more permanent nature be appointed to further develop and expand this resolution. This committee should consist of five people, one of whom should be the chairman.

7. The permanent committee work with similar committees in other potato-producing areas to develop a long-range agricultural program applicable to all potato producing areas.

Representatives of the Aroostook County Farm Bureau, Potato Industry Council, Institute of Starch Manufacturers and the P. & M. A. recommended, on the 31st of January, 1948, consideration by growers in Maine of a support program for U. S. grade No. 1 at 70 per cent of parity and price support for U. S. grade No. 2 and Size B at 45 per cent of parity.—VERNE C. BEVERLY.

NEW YORK

Table stock supplies seem to be lower than usual for this time of year, with prices rather firm at or above support levels.

Orders for certified seed are a little behind schedule, because of the uncertainty of potato growers regarding their acreage allotment and the high cost of production. Many growers are having labor problems since New York is a highly industrialized area with a good demand for skilled labor. It takes skilled labor to raise potatoes today because of the high investment in machinery and equipment.

There seems to be some sentiment for a long time potato program that would protect against disaster by covering costs, but low enough to prevent undue expansion. Marketing agreements are not, as yet, popular in the mind of the New York grower.

Although we expect an allotment similar to last year, there are indications from some sections that acreage will be reduced. Some of the larger growers are making quite drastic reductions.—H. J. EVANS.

SOUTH CAROLINA

The anticipated acreage of early potatoes in South Carolina is the same as last year. For several years the Cobbler has been losing ground as the leading variety and apparently 1947 was the last year it ruled. Inspection certificates on seed-arriving show both the Sebago and Katahdin ahead of Cobbler this year. The Pontiac acreage has also been drastically cut. The usual 2-3 per cent of Bliss and White Rose are now being planted.

Planting usually gets under way by the 1st of February but excessive rains have kept fields boggy and not more than 10 per cent of the acreage has been planted and it is now the 16th. Even if no more rain falls it will be the 1st of March before planting can be completed. Such late-planted potatoes usually do not yield as well as they should.

The washing program started last year, met with such success that the number of washers is being increased. Charleston County alone is expected to have 11 or 12 machines in operation by the harvesting period. When unwashed potatoes were being dumped last June, the washing machine operators could not fill all orders. Washed potatoes also brought a small premium. When shipped under refrigeration, washed potatoes carried quite well. Amazingly, a broker in Hamburg, Germany, wrote about purchasing potatoes as he had observed Army shipments of washed Carolina potatoes arriving there in excellent condition last summer. (Feb. 16).—W. C. BARNES.

PROVINCE OF ONTARIO

The potato crop in the Province of Ontario usually has an annual value of more than $20,000,000.00 and occupies about 125,000 acres. During recent years, potato growers have experienced increased diffi-

culty in producing scab-free potatoes in some sections. In the opinion of many good potato growers, the disease is progressively getting worse. The scab disease is now considered enemy No. 1 by the potato growers of the Province, causing not only enormous losses to producers, but extreme dissatisfaction to consumers. No practical measures are known that will satisfactorily control the disease, although many of our good potato growers have repeatedly carried out various suggested control measures.

With the above facts in mind, a committee of growers from the Ontario Crop Improvement Association recently met Col. the Hon. T. L. Kennedy, Minister of Agriculture, urging organization of all the various forces, so that the problem might be dealt with as effectively as possible with all the scientific results mobilized in the attack on it.

Col. Kennedy assured the delegation of immediate definite attention, and that sufficient funds would be made available to provide the necessary staff and equipment to undertake the work, under the direct charge of the Botany Department, Ontario Agricultural College, Guelph, in co-operation with other Provincial and Dominion Departments of Agriculture, National Research Council, Western University and all other interested parties. The committee of growers named by the Ontario Crop Improvement Association will act in an advisory capacity.

Growers have indicated they will establish a substantial fund to be used as an honorarium for practical accomplishments.—R. E. Goodin.

POTATO SPRAYING IN PENNSYLVANIA

The selection of a fungicide for potato foliage diseases is now more complicated than in the past since several materials have given fair disease control. We must consider these facts in choosing the materials we intend to use.

1. Bordeaux at the 8-4-100 strength (8 pounds bluestone, 4 pounds of lime in 100 gallons of spray) continues to prevent foliage diseases effectively. It sticks well (builds residue on the leaves) and the effect is lasting. It may, except under unusually severe disease conditions be used at 7-day intervals. Because of the harshness of this fungicide, yields have often been less than where other fungicides were used.

2. Fixed or insoluble coppers are showing promise for the control of potato foliage diseases. They stick fairly well to the foliage but not as well as bordeaux, and where used care must be taken to get complete coverage at each application. In many tests and demonstrations yields have been above those in bordeaux-sprayed plots. These increased

yields have resulted from the less caustic effects of the materials. The amount suggested for potato spraying is 2 pounds of actual copper in 100 gallons of spray. To determine the number of pounds of any "fixed copper" used, first find out how much copper it contains then calculate the number of pounds, of the form used, than are needed to make two pounds of actual copper.

3. Organic fungicides such as Dithane D 14, Dithane Z 78, and Parzate have given fair foliage disease control and excellent growth and yields. They have been used at the amounts and time intervals suggested by the manufacturing companies. These amounts are Dithane D 14, 2 quarts plus 1 pound zinc sulphate to 100 gallons of spray and Dithane Z78 and Parzate, 2 pounds to 100 gallons of spray. These materials seemingly lose their ability to control foliage diseases after 5 days so that spraying at 5-day intervals is needed. Extreme care must be taken to get complete coverage at each application. Since heavy plant development occurs where these materials are used, the maturity date of the potatoes is later than where other sprays are used, and increased yields, in this case, may depend on allowing the potatoes to grow until maturity is reached.

4. Zinc copper chromate (Crag) in experimental work has given excellent control of early blight and good control of late blight. Yields have equalled those secured with the fixed coppers. This material has been used at 3 pounds to 100 gallons of spray.

Whatever fungicide is selected for spraying, plans should be made to use DDT in combination with the fungicide. During the last three years the average yield increase obtained with the use of DDT has been more than 60 bushels per acre. DDT should be included in all sprays. Preferred for early season use on potato foliage are the DDT wettable powders. These powders should be used at the rate of 2 pounds of 50 per cent wettable DDT powder to each 100 gallons of fungicide. Later in the season liquid DDT emulsions (25 to 30 per cent concentration) may be used at the rate of 1 quart to each 100 gallons of spray. Injury is sometimes obtained on young potato vines with DDT emulsions.

Potato Dusts

Sprays have given better blight control and higher yields than have dusts in the same tests; however, some growers may continue to use dusts, because of water scarcity or for other reasons.

There are two types of dusts that can be mixed with DDT. Dithane or Parzate dust, and Fixed Copper dusts (7 per cent actual copper) can be combined with DDT to give satisfactory control of insects and partial control of diseases. These combination dusts should contain 3 per cent actual DDT in the finished dust.—O. D. Burke, H. Menusan, Jr.

NEW POTATO VARIETIES INTRODUCED IN 1947

The leaders of the potato improvement projects in Canada and the United States have supplied the names of the following potato varieties introduced in 1947:

Yampa: (CS6317: Katahdin x S245-186) white, midseason maturity in Colorado, field resistant to scab, early and late blight, leaf roll and mosaic. Immune to x virus.

LaSoda: (Triumph x Katahdin) bright pinkish red skin, one week later than Triumph, medium vigor and upright vine.

Waseca, Chicago, and Satapa are smoother than Cobbler, have ranked with Cobbler in yield and have produced a higher proportion of U. S.-One size tubers than Cobbler and Red Warba in extensive trials for 5 or 6 years in Minnesota.

The seven varieties introduced by Dr. Reddick range from early to very late in maturity. They are only slightly susceptible to late blight.

Thirteen new potato varieties introduced in 1947

Variety		Maturity (Early-Medium-Late	Reference
Yampa		M	L. A. Schaal USDA Colorado
LaSoda	red	M	Julian C. Miller Louisiana
Chicago		E	F. A. Krantz Minnesota
Satapa	red	M	
Waseca	red	E	
Cortland		L	Donald Reddick New York
Essex		E	
Fillmore		M	
Glenmeer	red	L	
Harford		L	
Madison		M	
Snowdrift		E	
Russet Sebago		L	G. H. Rieman Wisconsin

The relatively high resistance of these varieties may be fully adequate for areas where blight is not a serious problem. In blight areas they may relieve the grower of dusting or spraying throughout all but the latter part of the season.

Russet Sebago is a russet mutation of Sebago. It is more resistant to scab, and has a tougher skin which makes it better able to stand handling without injury. Russet Sebago has suffered slightly less scab·

injury than Russet Rural in Wisconsin trials. Scab pustules on Russet Sebago are usually shallow.

Inquiries for certified seed of these new varieties may be directed to Seed Potato certification officials.—HAROLD WATTSON, North Dakota Agricultural Experiment Station.

OUR ASSOCIATION RECOGNIZED

During my recent visit to many European countries I was very much pleased to learn that many scientific people were acquainted with our Association. I learned that several of them had been members and had received our magazine. Just now in occupied areas it is difficult to receive bulletins and technical material but this situation will clear itself as time goes on.

Many honors were accorded Mr. Mercker and myself because I represented the Potato Association. I want to pay tribute to our editor, Dr. W. H. Martin, who through the years has kept us on the map and I thought our membership would like to know just how we stood on the continent. (Mar. 31, 1948)—E. L. NEWDICK, *Pres.*

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RESEARCH ON POTATO INSECT PROBLEMS—A REVIEW OF RECENT LITERATURE[1]

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This review of the entomological research on potato insects in North America dates from January 1945 to the present (December 1947). However, since it seemed advisable to include all the important papers reporting DDT tests on potatoes, some 1944 articles are listed. The literature for 1947 in press obviously could not be considered here. In addition to studies of fundamental biological and ecological problems, research workers have been continuing their efforts to improve chemical control measures. Undoubtedly the outstanding feature of the period here covered was the rise and general adoption of DDT as an insecticide for use on potatoes. After an amazingly short period of testing, this one material has largely replaced the various insecticides formerly recommended for potato insects throughout North America.

APHIDS—HOST PLANTS AND CONTROL STUDIES

Because of their importance in the transmission of virus diseases, aphids are of considerable concern wherever seed potatoes are grown. In Maine, efforts to solve the aphid problem have involved a study of the relative importance of the host plants in that area (76). This work

[1]Published with the approval of the Director as Paper No. 443, Journal Series, Nebraska Agricultural Experiment Station.

[2]The writer is indebted to Dr. A. A. Granovsky and Dr. G. M. List for reading and constructively criticizing the manuscript.

indicated that year to year differences occur in the relative importance of the alternate hosts and that several years study will be required to evaluate properly the various host plants. One year a certain weed may be more important than another as a breeding host or as a source of infection. A better understanding of the aphid-host plant-virus complex should help explain the variations in amount of virus spread during different seasons and in different localities. The eradication of weed hosts is now advocated as a step toward the control of insect-carried diseases (77 and 85).

The use of insecticides is depended upon in most cases for the control of aphids and the search for a really effective material continues. Although information regarding the effects of chemicals on aphids may be found in several "control" papers to be reviewed later, a few deal primarily with aphids. Bronson *et al* (13 and 14) in Maine found a zinc nicotinyl fluosilicate dust, nicotine sulfate spray, a benzene hexachloride dust and DDT all effective. DDT applied as an aerosol, suspension, emulsion or dust was superior to a derris spray. Treated plots remained green much later in the season than did the untreated. Viruliferous winged aphids were attracted to the green foliage and as a result the sprayed plots were infected with more leaf roll than were the checks. Similar results were obtained in New York by Gyrisko *et al* (34). They reported DDT to be a better insecticide than such standard materials as nicotine, rotenone, and the thiocyanates. The green peach aphid, *Myzus persicae* (Sulz.), was more easily controlled than the potato aphid, *Macrosiphum solanifolii* (Ashm.), probably because of differences in the portion of the plants infested. Potato aphids feed in the rapidly growing terminals, whereas green peach aphids frequent the lower levels and are more apt to come in contact with DDT deposits. Frequent treatments are necessary to keep populations at a low level.

From all appearances in the field, Henderson (35) was able to reduce current-season spread of mosaic in Colorado with a DDT-Lethane spray combination. However, in a recent communication Henderson stated that greenhouse tests with tubers from the field plots gave no evidence of such reduction in spread. Late season spread of the mosaic virus apparently took place as was true in Maine for leaf roll.

Almost complete control of aphids was obtained with DDT in Florida (72). In recent laboratory and field tests hexaethyl tetraphosphate and other esters of phosphorous acids proved superior to nicotine (59 and 74). Considerable field testing of these new chemicals singly and in combinations along with tests of application methods soon may produce truly effective means of controlling aphids. At present DDT seems to be the most promising material to use for this purpose.

Flea Beetles—Taxonomy, Biology and Injury

For a long time it has been known that in certain western areas the principal flea beetle injury to potatoes is caused by the larvae feeding on the tubers, whereas in the eastern states a major portion of the damage results from reduced yields following foliage injury by the adults. After examining a large series of specimens and the published literature Gentner (23) concluded that there are at least three species of black flea beetles found on potatoes that have been considered under the one name, *Epitrix cucumeris* (Harr.). Two of these he described as new. The one in the western United States that commonly causes tuber injury was named *Epitrix tuberis* and designated as the tuber flea beetle. Apparently the tuber flea beetle reaches its eastern, and the potato flea beetle its western limits in Nebraska. The third species, *E. similaris* Gentner, has been found only in California (23).

In Nebraska the type of food plant consumed by caged tuber flea beetles was found to influence markedly oviposition and length of adult life (39). Potato foliage was the most satisfactory food, egg production being highest and mortality lowest on such a diet. The substitution of potato foliage for less nutritious diets was followed in two or three days by increased egg production, and a change from potato foliage to that of other food plants resulted in decreased egg production. In the field, larvae developed most readily and in largest numbers on potato roots and tubers. This study indicated that the elimination of all early plantings of potatoes would lower the general beetle population level by reducing the reproductive capacity and length of life of the overwintered adults. In the absence of potatoes, these beetles would be forced to feed, live and reproduce on less nutritious food plants, thus greatly decreasing the number of first-generation beetles available to infest late-planted potato fields.

The results of a seven-year study of the ecology and control of the tuber flea beetle have been summarized by Hill (41). This work included data on life history, seasonal history, factors influencing flea beetle abundance, such as rainfall, irrigation, host plants and date of planting the potato crop and insecticidal control tests.

Kulash (51) discussed the nature of flea beetle (*E. cucumeris*) damage to potatoes in North Carolina. During recent years he noted tubers from several fields with disfigurations caused by larval feeding severe enough to throw the potatoes out-of-grade.

Wireworms—Feeding Habits and Control

Feeding habits of wireworms, which are at present but little understood, have been studied by Greenwood (29) and Beard (6) in Con-

necticut. In control experiments Greenwood (30) found D-D ineffective under wet season conditions and he considered his results with DDT sprays and dusts inconclusive. More recently Greenwood (31) reported that practical and effective wireworm control could be obtained with from 2 to 2.5 pounds of crude benzene hexachloride (10 per cent gamma isomer) per acre applied in the form of a dilute dust with a grain drill. He also used benzene hexachloride as a seed-piece treatment and as an ingredient in poison baits with less success. Preliminary tests indicated that "benzene hexachloride applied in the row at 1.5 pounds crude material per acre or broadcast at 2.5 pounds crude material per acre does not contaminate the tubers."

Pepper *et al* (68 and 69) also made known preliminary results of wireworm control experiments with benzene hexachloride and DDT. The results with benzene hexachloride were outstanding. Fall applications of 1.6 pounds of the gamma isomer per acre and spring applications of 2.0 pounds of the gamma isomer per acre gave good control. A 25-pound application of technical grade DDT per acre was promising in one test. Sprays and dusts of benzene hexachloride applied to foliage also reduced the amount of wireworm injury to tubers. Although some off-flavor was detected in potatoes from plots treated with benzene hexachloride most tasters could not detect any impairment in flavor in these tests.

Potato Psyllid—Ecology and Disease Relationship

The results of a five-year study of the potato psyllid, *Paratrioza cockerelli* (Sulc) is reported in a paper by Wallis (96). This work was done in Nebraska and Wyoming and indicates that the insect does not overwinter in this area and that infestations originate from some outside source each year. Data concerning host plants and the relationship of temperature to the seasonal abundance of this important potato insect are also presented.

In a paper based on an examination of the weather records covering a 26-year period (1921-1946) Hill (40) correlated the very severe psyllid outbreak in Nebraska with an unusual weather sequence occurring that year. The summer was peculiar in that an extraordinarily wet July with very few hot days was followed by two months of exceptionally warm weather. Infrequent occurrence of hot July days permits psyllids to become established on the small plants in late-planted potato fields at a time when the foliage offers little protection from the heat. Later, when vine growth is dense enough to shade the lower portions of the plants and the soil surface, relatively high temperatures become essential for maintenance of optimum developmental conditions.

Under certain conditions a type of internal necrosis was found to occur as a tuber symptom of psyllid yellows (82). The same investigators, Snyder *et al* (83) also reported that typical spindling or hair sprout was induced by infesting plants approaching maturity with the potato psyllid. There was no evidence that a virus was involved and the condition was not transmitted through the tubers. It appeared that a toxin produced by the psyllid was responsible.

Six-Spotted Leafhopper—Disease Relationship

In experiments reported by Jensen and Tate (47), two out of 56 greenhouse-cultured potato plants exposed to viruliferous six-spotted leafhoppers, *Macrosteles divisus* (Uhl.), developed symptoms of aster yellows. The symptoms appeared 35 to 40 days after inoculation. Field-grown plants exposed to viruliferous leafhoppers failed to develop symptoms. Although viruliferous leafhoppers were found in western Nebraska potato fields, the time interval between the appearance of the insects in significant numbers and maturity of the potato plants is generally less than that required for development of the aster yellows symptoms. Bonde and Schultz (8) report the transmission of another virus disease by the six-spotted leafhopper which is thought to be different from purple-top wilt but resembling apical leaf roll.

A tuber condition known as net necrosis is common in certain potato-producing areas. This tuber condition has been associated with psyllid yellows. However, in experiments conducted by List (56) in Colorado, no evidence was obtained to show that psyllids cause net necrosis. Nevertheless, strong evidence was presented suggesting that net necrosis is an effect of aster yellows. Protection of plants from attack by six-spotted leafhoppers prevented both aster yellows in asters and net necrosis in potatoes.

Varietal Responses of Potatoes to Insects, Their Transmitted Diseases and Insecticides

The search for potato varieties resistant to insects continues and indications of progress have appeared in the literature. Recently the variety Sequoia was described (22) as having marked resistance to damage caused by flea beetles and potato leafhoppers. Likewise, moderate resistance to flea beetle, leafhopper and the tipburn complex has been claimed for the Potomac (46). Stevenson (86) recently summarized reports from various sections of the country regarding resistance and susceptibility of certain varieties to insects. In addition to the Sequoia and Potomac the variety Menominee was reported to be resistant to hopperburn in Ohio (86).

In experiments by Larson (54) in Wisconsin, Russet Burbank, Warba and Sebago varieties showed a high degree of resistance to yellow dwarf. The clover leafhopper vector, *Aceratagallia sanguinolenta* (Prov.), was as prevalent on resistant as on susceptible varieties. Folsom and Stevenson (20) obtained seedlings resistant to the natural spread of leaf roll and, in their paper, discuss and review pertinent literature regarding some of the factors affecting the spread of viruses by aphids. According to Bonde and Simpson (9) the varieties Teton, Pawnee, and Houma, possess resistance to leaf roll infection. In a study by Adams (1) the suggestion is made that "resistance to aphids in potato varieties may ultimately provide a means for the effective control of aphid-borne viruses in the field." This detailed study showed that potato varieties differ greatly in their reactions to the feeding of the green peach aphid.

One of the interesting recent trends in potato research involves the testing and evaluating of potato varieties in conjunction with the use of insecticides and fungicides. The yield of 13 varieties studied in Ohio by Sleesman and Bushnell (78) was increased after spraying with Bordeaux mixture. Bliss Triumph, a variety highly susceptible to leafhopper injury, gave the greatest increase, whereas the resistant Sequoia gave the smallest increase in yield. This work was continued with a combination spray of DDT and copper oxychloride sulfate, the results being recorded by Wilson and Sleesman (106). Responses to spraying were closely correlated with varietal susceptibility to potato leafhoppers. The three varieties with the highest leafhopper populations (Warba, Bliss Triumph and Pontiac) showed the greatest percentage increase in yield from spraying. Yield increases from spraying Sequoia, Russet Rural and Erie, varieties having lowest leafhopper populations, were lower.

Growth Responses of Potatoes to Insecticides and Insect Populations

Marked growth responses of potato plants treated with DDT have been observed by many individuals. Statements regarding this may be found in several of the general "control" papers (16, 33, 37, 38 and 80) and a few articles have appeared that deal specifically with this subject. According to Walp (98) plants sprayed with DDT had more leaves and the leaves were more flexible and contained a greater amount of chlorophyll. Wilson and Sleesman (105) studied the effects of spray materials on blooming. Bordeaux mixture caused the greatest decrease and DDT the greatest increase in amount of bloom. Various combinations of copper fungicides, organic fungicides, calcium arsenate and

DDT were also tested. In general, the copper fungicides depressed bloom whereas some of the organic fungicides caused slight increases. Combinations of DDT and organic fungicides increased bloom, Zerlate plus DDT practically doubling it. Where DDT was used alone, bloom was most persistent and increased as the amount of material applied per acre increased. DDT encouraged heavy vegetative growth. Plummer and Carter (70) were unable to demonstrate that DDT is translocated from the foliage to the tubers. Rumors of "plant stimulation" have been made frequently but to date no experimental data supporting such reports have been published.

The potato leafhopper, *Empoasca fabae* (Harr.), has long been recognized as a pest of potatoes but only now are we beginning to appreciate the full importance of its injuries. This is especially true, as is indicated in an article by Wolfenbarger and Heuberger (107), when the population is light. They point out that under such conditions more conspicuous pests and ailments often mask the damage being inflicted by the leafhoppers. These investigators noted that "Leafhopper densities and yields are significantly related, with increasingly greater yields from lower than from higher densities." The reduction of heavy populations increases yields, but the "elimination of the total population is much more effective in increasing yield than the control of, for example, 85 per cent of a dense population." Thus "one leafhopper in a light infestation is much more injurious than one in a heavy infestation."

It may be that a lack of appreciation for the damage caused by small populations of heafhoppers or other insects is responsible for the belief held by many that potato plants are stimulated by DDT. In the absence of proof of plant stimulation, it seems entirely logical to assume that the growth responses made by potato plants treated with DDT is due to the fairly complete removal of insect pests which have in the past inhibited normal plant development. This view is held by many entomologists and was expressed by Rawlins (71) when he stated "research men have found in DDT no magic that will influence good growth of potatoes unless insects are present in injurious numbers."

Field Techniques—New Aspects and Methods of Evaluating Results

The highly toxic and residual nature of DDT and other new insecticides is now requiring the utmost care on the part of investigators in order that they avoid making mistakes in their comparative tests. The importance of this is illustrated by Wilson and Sleesman (104) who found that the drift of small amounts of DDT from plot to plot

during application and the persistence of this material in the spray equipment were sufficient to affect materially experimental results. The drift problem is even more important when the insecticides are applied in the dust form. That reliable data may be obtained from experiments, entomologists must now give more thought and care to planning and conducting their field experiments than was generally believed necessary in the past.

Apple and Arnold (2) demonstrated that the specific gravity of potato tubers which has been used to evaluate varieties in fertilizer and cultural practice studies could also be employed as a means of determining the effectiveness of insecticides in the control of leafhoppers. They found that tubers having the highest specific gravity, *i.e.* the best eating quality, were from plots having the lowest nymphal populations and highest yields. The calculated pounds of starch produced per acre "was shown to be a better criterion of the effectiveness of the insecticides than the yields. . . ."

A paper meriting the attention of research workers is that of Sun and Shepard (88) which deals with methods of calculating and correcting the mortality of insects in both laboratory and field experiments. These investigators point out that misleading results are obtained with the usual methods of counting mortality especially for insects having rapid rates of reproduction such as aphids. An equation is presented which tends to eliminate this source of error.

Miscellaneous Insect Species and Problems

Landis and Getzendaner (53) have observed moderate to heavy populations of white flies, *Aleyrodes spiraeoides* Quaint., on potatoes in the Yakima Valley, Washington. In this same area the two-spotted spider mite, *Tetranychus bimaculatus* Harvey, has recently caused potato plants to die prematurely (52). This damage either seemed to be associated coincidentally with or caused by the use of DDT. The greatest amount of injury occurred in fields which had received four or five applications of DDT.

In Maine, Bean (5) records the presence of larvae of a syrphid fly, *Eumerus strigatus* Fallen, in decayed and diseased potatoes and shows the possible relationship of this insect to some potato rots and diseases.

The potato tuber moth, *Gnorimoschema operculella* (Zell.), was the subject of two articles. Boyd (11), working in New Jersey, came to the conclusion that this insect could overwinter only in the pupal stage. In California, Mackie (60) discussed the tuber moth problem with special reference to its quarantine aspects.

A five-year comparison of the relative abundance of potato flea beetles, leafhoppers and Colorado potato beetles, *Leptinotarsa decemlineata* (Say), has been published for North Dakota (63). This survey showed that leafhopper populations fluctuated most widely. According to a resumé of the Colorado potato beetle infestations in British Columbia (99), the work done by the Department of Agriculture in controlling that insect at a cost of less than $5,000 yearly is now resulting in an estimated annual saving of more than $100,000 to farmers in that Province.

In a paper that may anticipate a future problem in other areas Holcombe (43) traces the decrease in number of bee colonies in New Jersey to the dusting program used by farmers in controlling potato insects. The increased use of the airplane for the distribution of modern insecticides may multiply such reports in the next few years.

Werner (102) included a chapter on potato insects in his recent comprehensive bulletin on commercial potato production in Nebraska. He discussed briefly the insects involved, their injuries and the cultural and chemical control measures that have proven effective.

Early Investigations with DDT

Among the earliest reports regarding the effectiveness of DDT on potato insects in this country were the laboratory and greenhouse tests of Swingle and Mayer (89) and Weigel (100) and the small field plot tests of Howard (45). The more extensive field tests reported by Granovsky (25 and 26) further indicated that DDT was destined to become an important and useful insecticidal material for the control of potato insects. Although Granovsky's emphasis was on the control of potato flea beetles, potato leafhoppers and the tarnished plant bugs, *Lygus oblineatus* (Say), he observed that DDT reduced populations of other insects, such as the Colorado potato beetle, the six-spotted leafhopper, the alfalfa plant bug, *Adelphocoris lineolatus* (Goeze), and the rapid plant bug, *A. rapidus* (Say). The above research with DDT was done in 1943.

Chemical Control Literature Appearing in 1945

In 1944 DDT was tested widely on potato insects throughout the entire United States and Canada and late that year and during 1945 the results appeared in several papers. Some of these reports were preliminary in nature (19, 37, 42, 48, 73, 75, 90 and 97). A summary of the results obtained with DDT by the Division of Truck Crop and Garden Insect Investigations during the 1944 season was issued as a processed paper (103). Preliminary data from eighteen different state

agencies were collected by the Bureau of Entomology and Plant Quarantine and issued in a like manner (3). Almost without exception, these widely scattered experiments showed DDT to be superior to any other insecticide known for the control of most of the major insect pests of the potato.

In more detailed papers the story was similar. In Connecticut (93), "DDT dust at 0.5 per cent was more toxic to potato flea beetles than 50 per cent cryolite. On the same pest, 0.5 per cent DDT was as effective as 2 per cent rotenone." For European corn borer on potatoes 1 per cent DDT was as effective as 2 per cent rotenone, whereas DDT was outstandingly more effective than Bordeaux mixture against leafhoppers. In New York (33), DDT "produced very favorable reductions in infestations of Colorado potato beetles, aphids, flea beetles and leafhoppers." Sprays containing DDT gave "prolonged residual effectiveness." In Ohio (79 and 80) DDT "gave the most outstanding performance of any material that has been recorded for use on potatoes during the past twenty-five years. This insecticide used alone and in combination with various fungicides, gave remarkable control of the potato leafhopper, exceptional flea beetle control, and significantly higher yields (at the one per cent level) than those secured with any other treatment." In Iowa (16), a 3 per cent DDT dust "gave the best protection and the highest yield, nearly 70 per cent increase over the control." In Nebraska (38), field tests showed DDT to be more effective than any material yet tested against the principal potato insects, including tuber flea beetles, potato psyllids, potato leafhoppers and aphids. Also, it was more promising than anything yet tried for reducing populations of Uhler's leafhoppers, *Aceratagallia uhleri* (Van D.), ragweed plant bugs, *Chlamydatus associatus* (Uhl.), and pale legume bugs, *Lygus elisus* Van D., which often are abundant in Nebraska potato fields. Certain beneficial species also were reduced, but it was believed this would not prove detrimental under Nebraska conditions. In North Dakota (65), a 5 per cent DDT dust gave best yields in cooperative tests, whereas in Colorado (55) under conditions of a rather heavy psyllid infestation, higher yields were obtained with DDT dusts and sprays than with the then recommended liquid-lime sulfur sprays or sulfur-cryolite dust mixtures.

Granovsky (27) used various concentrations of DDT in combination with yellow cuprocide or tribasic copper sulfate. Combinations of DDT with 5 per cent yellow cuprocide "gave much better control of most of the potato insects than the same concentrations of DDT alone." The combination of DDT and pyrethrum also was found

promising. In this same article and in another (28) Granovsky pointed out that although DDT showed considerable residual value under field conditions, killing many common pests for two weeks or more, the lasting qualities were not so great on foliage as when the material was used indoors.

Goodhue *et al* (24) and Smith *et al* (81) tested the aerosol method of application of insecticides on potatoes in Maine. DDT aerosols proved effective against aphids, potato flea beetles, Colorado potato beetles, potato leafhoppers, tarnished plant bugs and six-spotted leafhoppers. Aerosols containing DDT were more effective than those containing derris or nicotine. Against potato aphids this method was very promising. The nature of aerosols is such that maximum contact is obtained and this method seems to produce better results under conditions of dense foliage than the conventional sprays or dusts. However, before aerosols can be adopted to field use, equipment to handle and apply the materials must be perfected. That doubtless will require considerable additional research.

Not all the papers appearing in 1945 dealt with tests of DDT. Wene and Rawlins (101) studied the compatibility of cryolite and certain copper fungicides. Bordeaux mixture delayed the toxic action of cryolite to the Colorado potato beetle, but apparently did not reduce the final kill. In Connecticut, Turner (92), experimenting with dust diluents having different pH values, found that "cryolite-talc (pH 9.1) dust was substantially less effective thna cryolite-pyrophyllite (pH 7.0) dust in controlling potato flea beetles. At best 50 per cent cryolite-talc was not as toxic as 12.5 per cent cryolite-pyrophyllite."

According to Campbell (17) in New Jersey certain neutral copper compounds did not equal Bordeaux mixtures as a repellent for flea beetles but neither was their use followed by reductions in yields, as so often happens when potatoes are sprayed with Bordeaux. Dithane gave relatively poor protection against flea beetles.

In preliminary tests reported by Turner (94) potato plants absorbed disodium ethylene bis dithiocarbamate (Dithane) from the soil in amounts sufficient to affect insects infesting the plants. When watered on the soil, European corn borer damage was reduced and substantial control of potato leafhoppers and tipburn was noted. There was some indication that Dithane was injuring the plants, but the four Dithane treatments outyielded the four Bordeaux treatments. This work arouses interest, for as stated by Turner, "The fact that an organic compound acted in this manner offers a very interesting new field for exploration." In this connection Pepper *et al* (69) more recently (1947)

observed less leafhopper injury to potato plants growing in soil treated experimentally with benzene hexachloride for the control of wireworms. The plants in treated plots remained green much longer than did those in untreated check plots, which led the investigators to believe "that some substance toxic to the potato leafhopper was taken up by the plants from the benzene hexachloride plots."

Chemical Control Literature Appearing in 1946

An inspection of the "control" articles published in 1946 revealed that most investigators emphasized tests of DDT and fungicide combinations during their 1945 experiments. A summary of results with DDT in Connecticut, Nebraska, New Jersey, New York, Ohio and Pennsylvania was assembled and published in the *American Potato Journal* (4). Some of the findings follow:

In Connecticut, DDT provided superior control of leafhoppers and tipburn and gave yields as high as those secured with Bordeaux mixture. Where flea beetles were abundant, DDT alone produced a higher yield than did Bordeaux mixture alone. In a Nebraska experiment, a dust containing 3 per cent DDT in pyrophyllite and one containing 1 per cent DDT fused with sulfur gave similar degrees of control of tuber flea beetles in plots 24 hours following application. However, the DDT-sulfur dust remained more effective over a period of several days and continued to kill many newly developed beetles as they emerged from the soil. In another test, soil treatments with DDT significantly reduced the amount of flea beetle larval damage to the tubers. The data indicate that this method of fighting tuber flea beetles might, with some refinements of formulations and means of application, be of value under certain conditions. In 1945, for the first time in Nebraska, airplanes were used for the application of insecticides to potato fields. DDT dusts applied in this manner and by ground dusters gave excellent kills of tuber flea beetles. However, ground machinery appeared more effective than airplanes against leafhoppers and mirids. In New Jersey under conditions of a low insect infestation, DDT plus Bordeaux or tribasic copper (Microgel) applied to Katahdin potatoes resulted in yield increases of 86 and 34 bushels per acre, respectively. A 3 per cent DDT-copper-lime dust was ineffective and gave no yield increase, whereas a 3 per cent DDT-tribasic copper-talc dust reduced the leafhopper population slightly and increased yields 38 bushels per acre. In New York where DDT proved very satisfactory in comparison with other insecticides for aphid control, it was found that the amount needed to keep aphids adequately in check was higher than for other potato insects. By increasing the amount of DDT up to 2.25 pounds

per acre progressively increased yields and better aphid control resulted. When emulsions were used comparable results were obtained with one-fourth the amount of DDT necessary when used in wettable powder form. In Ohio DDT in combination with various fungicides produced an average yield increase of 51 per cent (141 bushels per acre) over that obtained with combinations of calcium arsenate and the same fungicides. DDT "completely eliminated the potato leafhopper as a factor in reducing yields," gave better control of flea beetles than did calcium arsenate and when "applied at 10-day intervals throughout the growing season, gave good control of aphids." In field demonstrations in Pennsylvania DDT was shown to increase yields in proportion to the number of applications made during the season.

Bonde and Snyder (10) reported yield increases varying from 16 to 32 per cent when DDT was used with different fungicides. Since certain shortcomings of the neutral copper and organic fungicides appeared to be offset when used with DDT, these investigators stated that such combinations may replace Bordeaux mixture. Their work further showed that "the protective value of some spray fungicides for the control of early and late blight has increased when used in combination with DDT. Also the protective value of DDT for the control of flea beetles likewise was increased by being combined with a fungicide." Heuberger and Stearns (36), in summarizing their compatibility study, state "DDT gave excellent leafhopper control and high yield responses; DDT has no fungicidal value; DDT is non-injurious to potatoes when used alone or in combination with the fungicides tested; DDT and several inorganic and organic fungicides are compatible since each material was as effective when used in combination as when employed alone."

It was evident from a test conducted by Thurston (91) in Pennsylvania "that greater increases in yield may be expected from the combination of DDT with certain organic fungicides such as Dithane, then with Bordeaux mixture, or from a combination of DDT with any fungicide which by itself has poor insecticidal or repellent properties." The Dithane and DDT combination also gave higher yields than Bordeaux mixture and DDT in Ontario tests, according to Berkeley *et al* (7). When added to copper-lime dust DDT was ineffective in controlling leafhoppers, and Lethane B-72 was inferior to DDT as a control for this insect. In another Canadian paper (21) results with DDT were similar but differences caused by fungicides were not considered significant.

List and Edmundson (57) also found DDT to be compatible with Bordeaux and Dithane. Sprays containing basic copper arsenate, DDT alone or with Bordeaux mixture or Dithane gave highly significant and

equal control of tuber flea beetles. Based on the amount of tuber injury 3 per cent DDT dusts, at the rate of 25 pounds per acre, failed to control the tuber flea beetle. However, figures given for the adult population show significant control suggesting that the lack of control of larval injury may have been caused by improper timing of the applications. *Lygus* populations were reduced by both lime-sulfur sprays and DDT, whereas all DDT treatments significantly reduced the numbers of leafhoppers.

A total of 16 spray and 17 dust combinations were tested by Munro and Hoyman in North Dakota (64). Treatments with DDT gave highest insect kills; dichloro diphenyl dichlorothane (DDD) and arsenicals ranked lower in that order. The six-spotted leafhopper showed highest resistance to the treatments, whereas potato leafhoppers, potato flea beetles and Colorado potato beetles showed lower resistance in that order. The most effective combination spray contained zinc-dimethyl-dithio-carbamate (Zerlate) and DDT. Zerlate and DDT also were included in the most effective dusts. Copper A-DDT and Copper A-Zerlate-DDT dust combinations were also good.

Brandes and Swisher (12), also working in North Dakota, tested spray and dust treatments in large field demonstrations. DDT sprays and dusts again gave higher degrees of insect control. Little or no differences in yields were obtained with Dithane-DDT, ferric-dimethyl dithiocarbamate (Fermate)-DDT, Copper A-DDT, Dithane-arsenicals and Cuprocide-DDT sprays. However, Dithane-DDT outyielded the general group of copper-arsenicals by 22.2 to 62.3 bushels per acre. Yield differences in dust plots were only slightly significant but "the copper-DDT plots outyielded copper arsenical plots 8.3 to 44.3 bushels per acre."

In field trials on Long Island, Gyrisko (32) found a mixture of DDT isomers, DDD and DDT equally effective in their toxicity to and residual action on flea beetles and leafhoppers. A new insecticide dust containing piperonyl cyclohexanone added to pyrethrum marc (PCH) and a 3-way dust (containing rotenone, sulfur and pyrethrins) gave good initial kills but did not possess the lasting qualities of DDT and its related compounds. Lethane B-71 was ineffective against flea beetles and was "only fair" for the control of potato leafhoppers.

According to Zappe and Turner (108) one pound of DDT per acre in a xylene-kerosene mixture applied with a helicopter gave promising results for flea beetles and potato leafhoppers. However, the residue from this concentrate was not heavy nor persistent and flea beetles soon repopulated the fields. Campbell and Filmer (18) obtained no out-

standing results with benzene hexachloride in preliminary tests in Pennsylvania but considered the material worthy of further study.

Chemical Control Literature Appearing in 1947

In 1947 papers appeared reporting results with several newer insecticides. By then DDT was generally "accepted" and often used as a standard for evaluating the new chemicals. Brooks and Anderson (15), working in Virginia, found a DDT spray mixture very effective against the potato aphid, and a 0.6 per cent gamma benzene hexachloride dust superior to a 3 per cent DDT dust mixture against this insect species. A calcium arsenate-Bordeaux mixture spray seemed to give best results in reducing the amount of flea beetle damage to the foliage. There was no difference between the various dusts with respect to flea beetle control.

Kido and Allen (49) compared the efficiency of a colloidal DDT with other types of DDT formulations in the field. On potatoes good initial kills of insects were obtained, but the colloidal material seemed to have poor residual qualities as compared with the more conventional emulsions and wettable powders.

Vaughn and Leach (95) tested some exploratory chromate compounds and found that, in addition to their fungicidal properties, they appeared to have some value as insecticides against leafhoppers. Since these observations were made under light leafhopper populations, these men concluded that further experiments under conditions of heavy infestations were needed to evaluate properly the insecticidal properties of the chromate compounds.

According to Horsfall and Turner (44) Dithane alone or with zinc sulfate and lime was almost without effect on leafhoppers or flea beetles in Connecticut. They concluded that in areas where these insects are troublesome, Dithane cannot succeed alone. In a wet season with few insects Dithane outyielded DDT, whereas in a dry season with no disease DDT treated plots outyielded those treated with Dithane. From this the authors further concluded that each of these organic materials "must supplement the other in a complete potato spray."

Stitt (87) working in western Washington found that dusts containing DDT, DDD, DMT (1-trichloro 2, 2-bis (p-methoxyphenyl)-ethane) or benzene hexachloride mixed with C.A.C. (Copper A Compound) were superior to calcium arsenate-monohydrated copper sulfate-lime mixture for the control of flea beetles and aphids. The effectiveness of DDT, as measured by control of aphids and yields, was not affected when used in combination with four different fixed copper fungicides. Stitt also measured the effects of mechanical injury to potato

vines by dusting equipment. Various amounts of wheel damage caused significant to highly significant reductions in yields.

In Michigan Morofsky and Muncie (61 and 62) tested several insecticide-fungicide combinations. In addition to DDT, benzene hexachloride and a chlorinated camphene were used as insecticides. None of the materials tested gave any better control than did DDT alone or in combination with Bordeaux or the fixed coppers. In dusting experiments the combining of DDT with monohydrated copper sulfate-lime was not followed by reduced yields. Thus the lime did not lessen the effectiveness of DDT in that instance. However, yields were apparently reduced by the addition of benzene hexachloride to Bordeaux mixture or to the zinc and copper salts of nitrodithioacetate.

List and Payne (58) reported promising results with 1-trichloro-2, 2-bis-(p-bromophenyl)-ethane referred to as Colorado 9. This chemical is closely related to DDT and when used in the field on potatoes showed promise of controlling psyllids, tuber flea beetles and leafhoppers.

Roark (74) in his digest of information on hexaethyl tetraphosphate listed some results from an unpublished report by Chapman, Voss and Allen of the Wisconsin Agricultural Experiment Station. These investigators obtained a 90 per cent kill of potato aphids with hexaethyl tetraphosphate (1 pt. (50 per cent) per 100 gallons of spray) as compared with a 25 per cent kill with nicotine sulfate (1.6 pt. (40 per cent) per 100 gallons). This new chemical also showed considerable toxicity against potato leafhoppers and the six-spotted leafhopper. Against the latter species a 1:800 spray was more effective than 2 pounds of DDT per 100 gallons of water. Against potato flea beetles hexaethyl tetraphosphate was inferior to DDT.

Stearns *et al* (84) and Parker and Beacher (67) tested in a preliminary way chlorinated camphene (Toxaphene) against potato leafhoppers and concluded that further experiments would be required before its status could be determined. The material produced a severe chlorosis of the foliage to Dakota Red and Irish Cobbler potato varieties when sprayed with a suspension of 1 pound of 50 per cent powder in 100 gallons of water.

O'Kane (66) reported that benzene hexachloride controlled Colorado potato beetles and potato flea beetles and that good kills of aphids were obtained, but for potato leafhoppers this material was not satisfactory. He also emphasized that crude benzene hexachloride caused objectionable odors in some food products and that potatoes were susceptible. He further stated, "Either soil conditions, or variety, or both, may have

an influence. Although no off-flavor was in evidence in some tests, an unpleasant flavor was present in others."

Kulash (50) tested some of the newer DDT formulations and other organic insecticides for the control of Colorado potato beetles in North Carolina. DDT formulations with the exception of one containing a high ortho-para isomer content gave good control. Chlordane was good but not superior to DDT; a piperonyl cyclohexanone-pyrethrum concentrate was poor and although benzene hexachloride was good, it had no great residual qualities. No phytotoxic effects were noted and no taste or odor was found in tubers cooked or raw one month after treatment with any of the materials used. DDT and benzene hexachloride were equally effective in killing potato flea beetles in other tests reported by Kulash (51). However, a 3 per cent DDT dust seemed to outlast any of the tested water miscible DDT spray concentrates or benzene hexachloride spray.

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   E-644g Texas Agr. Exp. Sta.
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EFFECT OF SPRAYER-WHEEL INJURY ON THE YIELD OF POTATOES

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It has been known for some time that the injury to potato plants caused by the sprayer has some effect on yield. The extent of this effect and any differential among varieties as to their susceptibility are not well established.

An opportunity to study these factors was afforded by a replicated and randomized variety yield test at Richford, New York, in 1947. This test included 26 varieties in four replications arranged according to season of maturity in randomized blocks. The test was planted on the 28th of May and was completely killed by frost on the 22nd of September before any but four of the varieties were naturally matured. The plot was sprayed frequently throughout the season with a power sprayer equipped with a 10-row boom and hauled by a four-wheel tractor, the sprayer and tractor straddling two rows. No vine lifters were used. The same wheel-rows were used throughout the season, injury being confined to one side of any given row. Since the planting plan did not provide for randomizing to equalize or neutralize sprayer-wheel injury, in plotting the injured rows it was found that two of the 26 varieties were not contacted at all, whereas the remaining 24 varieties were next to the sprayer and tractor wheels in one, two or three of the four replications. This made it possible to compare yields of the injured with the uninjured replications of each of 24 varieties. In no case was the stand of plants less than 96 per cent and in only five of the 26 varieties was it less than 100 per cent. Therefore stand need not be considered when significance of yield differences is applied.

A comparison of yields of No. 1 sized tubers on injured and uninjured plots of each of 24 varieties of potatoes is given in table 1.

Discussion

The weighted average yield of all varieties affected by sprayer-wheel injury was reduced by 108.0 bushels to the acre or by 22.0 per cent. There were three varieties, namely, Snowdrift, Sir Walter Raleigh, and Pontiac, which actually averaged a higher yield in the injured than in the uninjured replications. For this there is no obvious explanation since the stand of each was 100 per cent. The significance of the

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TABLE 1.—*Effect of sprayer-wheel injury on yield of potatoes*

Variety	Yield of No. 1 Size Tubers in Pounds per Plot					
	Not Injured		Injured		Difference	
	No. of Plots	Yield	No. of Plots	Yield	Yield	Per Cent
Warba	3	52.2	1	34.0	18.2	34.9
Red Warba	1	48.0	3	35.0	13.0	27.1
Cobbler	2	48.8	2	32.8	16.0	32.8
Chippewa	1	52.0	3	39.2	12.8	24.6
Chenango	1	38.0	3	28.3	9.7	25.5
Genesee (y)	4	42.6	0	——	——	——
Essex	3	57.8	1	44.5	13.3	23.0
Houma	3	35.0	1	31.0	4.0	11.4
Ashworth	1	63.5	3	48.2	15.3	24.1
Snowdrift	2	33.8	2	41.5	7.7(x)	22.8(x)
Green Mountain	3	53.5	1	43.0	10.5	19.6
Mohawk	2	55.5	2	38.5	17.0	30.6
Placid	2	63.3	2	41.8	24.5	38.7
Virgil	2	52.8	2	47.5	5.3	10.0
Katahdin	3	45.5	1	19.0	26.5	58.2
B70-5	1	71.5	3	48.3	23.2	32.4
Sir Walter Raleigh	3	35.7	1	45.5	9.8(x)	27.5(x)
Russet Rural (y)	4	36.3	0	——	——	——
Pontiac	3	38.8	1	45.0	6.2(x)	16.0(x)
Sebago	2	58.0	2	51.8	6.2	10.7
Teton	3	58.7	1	39.5	19.2	32.7
Erie	3	49.5	1	25.5	24.0	48.5
Ontario	2	56.5	2	44.3	12.2	21.6
Empire	2	61.5	2	44.5	17.0	27.6
Fillmore	2	45.8	2	32.0	13.8	30.1
Sequoia	2	67.0	2	34.3	32.7	48.8
Totals	52	1242.7	44	935.0		
Ave. (Unweighted)		51.78		39.0	12.78	24.7
Ave. (Weighted)		50.75		39.6	11.15	22.0
Ave. bushels per acre		491.3		383.3	108.0	22.0

(x) Difference in favor of sprayer-wheel injury.
(y) Not included in totals.

22 per cent reduction in yield of the affected plots has not been determined statistically. Whether the odds are high enough to be considered significant even at the 5 per cent level can perhaps be judged from the fact that of a total of 96 plots eligible for comparison there were 11 instances in which any one of the one or more injured replications of a given variety outyielded the corresponding uninjured plot or plots. On the basis of paired comparisons, this is a ratio of about 8 to 1 in favor of the uninjured replications.

It may be noted from the data in table 1 that the reduction in yield from wheel injury among the 21 varieties showing a reduction ranged from 10.0 per cent for Virgil, a rank growing, blight-resistant variety, to 58.2 per cent for Katahdin, a variety of perhaps only average plant size. The percentage reduction yield from wheel injury was actually higher for such early, small, upright growing varieties as Warba and Cobbler than the average for all adversely affected varieties which was 29.2 per cent. Therefore, any differential response of varieties to wheel injury does not appear obvious in this instance. These observations are incidental to the interpretation of yield results from a replicated potato variety test not designed to study the subject of sprayer-wheel injury. However, they appear to be of enough significance to draw attention to the importance of this factor in the design and interpretation of results from yield trials.

Conclusions

A comparison of yields from sprayer-wheel injured and uninjured replicates of 24 varieties of potatoes grown in 1947 in Tioga County, New York, seem to justify the following conclusions:

1. Under favorable conditions of high elevation, high soil fertility level, and ample rainfall for potato plant growth, yield may be reduced from 10 to more than 50 per cent by vine injury caused by sprayer and tractor wheels.

2. In any well planned variety test a few instances of no yield reduction from wheel injury may occur. These must be explained on the basis of experimental error, soil variability or some other influential factor not always obvious.

3. The extent of wheel injury to the growing potato plant does not appear to bear any significant relation to season of maturity or habit of growth of the variety.

4. Potato experiments and particularly potato variety yield tests should be so designed that the factor of sprayer-wheel injury can be either neutralized or taken into account in the interpretation of results.

PRESENT STATUS OF THE GOLDEN NEMATODE OF POTATO

W. A. McCubbin

Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, United States Department of Agriculture, Washington, D. C.

The present status of the golden nematode can be best understood by discussion under three heads: *Survey,* to locate areas where the pest is present; *control,* to suppress it in field or crop; and *quarantine,* to prevent spread.

Survey.—The golden nematode is essentially an external root parasite of the potato and tomato, living over in soil for eight or more years, and retarding potato plant growth and tuber size by feeding on the root system in immense numbers. It was probably brought here from Europe, where it has been known for years as an important potato pest. It was first recognized in 1941 in fields near Hicksville, Long Island, though it had probably been present there several years previously.

Surveys in Long Island have enlarged the known infested acreage from the few original centers first observed to nearly 6000 acres at the end of December, 1947, all but 30 acres of which are in Nassau County. Except for this one field, it has not been found in extensive surveys in Suffolk County, and none has been found in a general survey in the northeastern states in 1944, or in survey in 1947 in Steuben County, New York, and in 3000 acres examined in Maine.

The Long Island infestation still represents the only known occurrence of this pest on the continent to date.

Because light infestations of the parasite produce no distinctive symptoms on tops or tubers, it is necessary to look for the nematode itself, either by the examination of potato roots in the season of vigorous growth, or by a soil sample method by which the nematode cysts (mature egg sacs) are separated out by washing and screening from numerous ounce lots of soil taken in grid pattern over a field. By neither method can slight infestations be detected with certainty. Consequently, nematodes may be present in low concentrations for several crop years before they can be detected successfully, and thus have much opportunity to spread elsewhere before they are found.

Summary of report presented to the New Jersey Potato Growers' Association, Trenton, New Jersey, January 29, 1948.

Control.—Several soil fumigants, including D-D, have given a high rate of kill, but none of these under field conditions has approached complete destruction. Hence soil treatment could only be expected to reduce nematode damage temporarily; starvation is the only reliable means yet known to accomplish eradication.

Methyl bromide will kill the nematode in potato lots and adherent earth, but at effective dosage rates tuber injury is encountered.

Various chemical baths have been tried on tuber lots. The most promising has been ammonia in heated solution. It is not yet commercially practicable, however, and needs further investigation.

Washing and brushing methods will remove a considerable percentage of the nematodes from tubers, but those still left on the tubers constitute a danger of spread that cannot be ignored.

Quarantine.—Measures which aim to prevent the spread of the golden nematode must take into consideration numerous carriers. Predominant are potato shipments, together with their adherent earth and debris and soil in sacks, containers, trucks, and railroad cars. Other root crops which bear away adherent soil are likewise dangerous. All nursery stock and any other type of plant grown in infested soil can carry the pest in adhering earth to a new location. Topsoil movement is especially objectionable. Other effective means of local spread are farm implements and soil carried on automobiles, trucks, tools, containers, or on the feet of man as well as of domestic and wild animals. Flood and surface wash are effective local carriers, as is also wind.

Quarantine effort must control all these means of spread to keep the golden nematode bottled up within its present area. In a heavily populated area, such as Long Island, where there is intense and varied activity, it is a herculean task to stop outward spread, and if heavy nematode populations are allowed to build up in the infested lands by continued potato production, any permanent prevention of spread is practically out of the question.

The quarantine measures taken during the last three years in restricting crop movement from known infested fields to relatively safe disposal channels, the withdrawal of approximately 1500 acres from potato production in 1946 and 3500 acres in 1947, and the treatment of some 1500 acres with D-D—have reduced the over-all chance of spread to a low point. When one considers in addition that practically all fields in which the nematode was discovered in 1947 had very light infestation, the danger of spread to date has been extremely small.

However, the golden nematode is not a merely local problem but is one of critical national interest. On the basis of present knowledge,

it would be indefensible to allow a pest of such potential destructiveness to spread to our immense potato areas if it can be held within present bounds. As matters now stand, the most effective action that can be advocated is to suspend promptly and completely potato and tomato culture in all the known infested and exposed land.

Acknowledgments

The writers are indebted to Dr. G. P. McRostie, Head of the Department of Field Husbandry, Ontario Agricultural College, for advice and criticism; and to the Staff of the Dominion Rubber Research Laboratories, Guelph, for supplying 2, 4-D used in these experiments.

NEW POTATO VARIETIES INTRODUCED IN 1947

HAROLD MATTSON[1]

North Dakota Agricultural Experiment Station, Fargo, N. D.

Leaders of potato improvement projects in Canada and the United States have supplied the names of the following potato varieties introduced in 1947:

TWELVE NEW POTATO VARIETIES
INTRODUCED IN 1947

Variety		*Maturity* (Early-Medium-Late)	*Reference*
LaSoda	red	M	Julian C. Miller Louisana State U.
Chisago		E	F. A. Krantz
Setapa	red	M	U. of Minnesota
Waseca	red	E	
Cortland		L	Donald Reddick
Essex		E	Cornell University
Fillmore		M	
Glenmeer	red	L	
Harford		L	
Madison		M	
Snowdrift		E	
Russet Sebago		L	G. H. Rieman U. of Wisconsin

[1]Horticulturist, North Dakota Agricultural Experiment Station.

LaSoda: (Triumph x Katahdin) bright pinkish red skin, one week later than Triumph, medium vigor and upright vine.

Waseca, Chisago, and Satapa are smoother than Cobbler, have ranked with Cobbler in yield and have produced a higher proportion of US-One size tubers than Cobbler and Red Warba in extensive trials for 5 or 6 years in Minnesota.

The seven varieties introduced by Dr. Reddick range from early to very late in maturity. They are only slightly susceptible to late blight. The relatively high resistance of these varieties may be fully adequate for areas where blight is not a serious problem. In blight areas they may relieve the grower of dusting or spraying throughout all but the latter part of the season.

Russet Sebago is a russet mutation of Sebago. It is more resistant to scab and has a tougher skin which makes it better able to stand handling without injury. Russet Sebago has suffered slightly less scab injury than did the Russet Rural in the Wisconsin trials. Scab pustules on Russet Sebago are usually shallow.

Inquiries for certified seed of these new varieties may be directed to Seed Potato certification officials in the various states.

SECTIONAL NOTES

ALABAMA

Our potato crop has passed through one crisis after another. Cold and wet weather at planting time retarded the operation. This was followed by heavy rains in early March and now a general infestation of late blight is reported in some fields. The growers have attempted to overcome the loss of nitrogen resulting from heavy rainfall by making side-dressing applications of fertilizer. Spraying or dusting for the control of late blight is being generally practiced. Despite all our difficulties, prospects seem to be a little better than normal for this time of year.—FRANK GARRETT.

FLORIDA

Approximately 11,000 acres of potatoes are being grown in the Hastings Section this year. Several thousand acres were replanted during January and February since the seed decayed in soil that was waterlogged by 4.08 inches of rainfall during a 5-day period (Jan. 20-24).

Disaster threatened again in March when rains totaling 8.04 inches fell from the 2nd to 13th. However, prompt application of

fungicides to the crop immediately after the rains ceased and frequent applications thereafter have prevented the occurrence of a disastrous epidemic of late blight.

Digging of the early-planted fields started this week. However, most of the crop is late and harvesting of the entire acreage will probably not be completed until the 1st of June.—A. H. EDDINS.

MAINE

The Blue Tag Certified Seed campaign conducted by the Extension Service is apparently a decided success. The campaign was inaugurated in an effort to get every table stock grower to plant Blue Tag Certified seed. It was felt that such a program would help eliminate ring-rot from local seed. Growers report that sales of certified seed for use in the county are far ahead of any previous year.

Everything points to the fact that Maine farmers are still within their potato allotment program of approximately 186,000 acres.

To date the Government has purchased about 26 per cent of all the potatoes grown in Maine. This does not necessarily mean that Maine has all this surplus. Much of this 26 per cent could rightly be charged against the Northwestern states.

E. L. Newdick, President of the Potato Association of America, is back from Europe and gave an excellent report of his trip to those in attendance at Farm and Home Week on the 8th of April.

Two dates of interest to potato men should be the American Potato Blossom Festival which will be held at Van Buren, Maine, on the 21st of July. The Potato Blossom Queen is selected as part of the festivities. Bill Stempfle of Steuben County, New York, is making preliminary plans for a tour of Aroostook during the week of the 19th of July.

A recent survey by the P. & M. A. showed 14,409 cars of potatoes on hand after the 1st of April.

A new variety "Kennebec" is in great demand but the Maine State Seed Board controls practically all of this variety. It will be grown under their supervision on a farm which was purchased this year for the purpose of multiplying the best seed stocks in the state.—VERNE C. BEVERLY.

NEBRASKA

As of the first of April, practically all potatoes in Nebraska had been sold or were contracted for sale, and the processing plants were completing their operations for the year. Some of them have already shut down for the season. A very few shipments of certified seed po-

tatoes, principally of the Red Warba variety, remain undelivered. These are moving out rapidly to the central and eastern parts of Nebraska, where planting usually gets under way right after the first of April. Because of somewhat unsettled weather conditions, very little planting has taken place yet, although it is considered that this area can plant safely up through the first half of April.

Planting intentions for the late main crop in the western part of the state are not very well established at this time. Considering the sales of local seed, both certified and commercial, it is apparent that the acreage will be about the same as last year, which was below 1946. In view of the fact that good prices were paid for the commercial crop during the past winter, it seems that the acreage should be somewhat increased. A summary of prices paid growers reveals that the average price for U. S. No. 1 grade washed potatoes was between $3.40 and $3.50 per cwt. f.o.b. cars. This excellent price is considered as an incentive for the maintenance of the usual acreage, and possibly for some increase of acreage this coming year.

The competition of other crops with potatoes that have been high yielding, and high priced, is very strong. Principal among these crops are wheat, sugar beets, and dry white beans. Farmers, in general, in this area have enjoyed a very successful season.—MARX KOEHNKE.

NEW JERSEY

Potato planting in New Jersey has been slightly delayed by cold wet weather but it is expected that all of the anticipated acreage, estimated a t58,000, will be planted by the 1st of May.

Considerable frost injury and stem-end discoloration have been found in seed received from the northern states but otherwise the seed has been satisfactory. The majority of the stem-end discoloration is believed to be caused by the use of vine killers. According to present information this type of browning will not injure the prospective yield.

Growers are using considerably more fertilizer than is recommended by the Experiment Station. With potatoes selling at relatively high prices it takes a very small yield increase to pay for the extra fertilizer used. However we have every good reason to believe that much of the excess fertilizer is wasted and if such should be the case during a dry year a reduction in yield would automatically result.

The neutral coppers have practically replaced monohydrated-copper in dusts used for blight control and they are also being widely used in the place of copper sulfate in potato sprays.—JOHN C. CAMPBELL.

NEW YORK

The table stock deal in New York State is about over. There are a few odd lots but most growers are through and working on the land. Our markets for the past two weeks have been dull.

Certified seed business is good. Growers were late in getting allotments and making plans but with the advent of spring weather the seed potato business came along like spring flowers.

In general, the growers are much distressed by the possible provisions of the Support Program. They do not like to have their responsibility go any further with potatoes sold to the Government than they do when they sell them to other buyers. They feel that unless they are allowed to use good shipping judgment they should not be responsible for potatoes left on the track indefinitely, shipped in too hot weather or otherwise delivered different than commercial practice has indicated being proper.

There is some agitation for a Long Time Potato Program including Marketing Agreements, utilizing and support of low grades and off sizes with ample research to increase consumption. Our growers seem to be in favor of a price support level high enough to prevent disaster in adverse years and low enough to discourage speculative planting. They think that marketing agreements and the other provisions will mean a steady supply of quality potatoes for the consuming public at a fair price.

On the 10th of April some potatoes were being planted in the early sections of up-state New York. Planting in this area will not begin to be extensive however, for another month.—H. J. EVANS.

SOUTH CAROLINA

Excessive rains have hampered all farm operation in Coastal South Carolina since last fall. Potato planting began on schedule about the 1st of February, but was interrupted every few days by rain. Normally our planting operation is completed by the first week of March, but considerable acreage was planted rather late in the month. Some of our acreage was re-planted after the seed decayed, whereas a small acreage was planted to other crops. Estimates on loss in stand vary from 25 to 50 per cent. The plants that have emerged are spotted over the fields on the better drained areas. This makes it necessary to cultivate, dust, etc., the entire acreage in order to care for the 50 to 75 per cent stand. It is doubtful if South Carolina can produce more than one-half a normal crop even if conditions are excellent from now until harvest.

Growers are planning to wash as many potatoes as last year, in

fact, it is hoped that a large portion of the crop will move to market washed and refrigerated.

Seed inspections indicate that Sebago and Katahdin comprise nearly three-fourths of the acreage. The Cobbler, which ten years ago comprised 95 per cent of the acreage is now down to 10 to 15 per cent. Pontiac and Bliss comprise about 5 per cent of the 1947 acreage and White Rose approximately 3 per cent.—W. C. BARNES.

SOUTH DAKOTA

Potato planting will start in South Dakota about the 15th of April, which will be nearly two weeks earlier than last year. The acreage in the certified area will be about the same as last year. There may be a slight decrease in the commercial acreage planted. Shipments of the 1947 crop are about completed at this writing. White potatoes were slow with many cars going to the P. and M. A. at $2.75 per cwt. The Government took 147 cars of the 1947 crop. These went for school lunches, relief, storage and for the manufacture of potato flour.

E. A. Fletcher was elected President of the South Dakota Potato Growers' Association and C. A. Larkin, Vice President, at the annual meeting, March 18. Marx Koehnke of Nebraska flew in for the annual meeting and talked on certification problems.

Applications have been received for the position of head field inspector from a number of well-qualified men and one will be selected soon.

The association will also work with South Dakota State College in securing a plant pathologist to work on disease problems and seed selection.—JOHN NOONAN.

VIRGINIA

Present prospects are for a late but heavy crop of early commercial potatoes. Growers were later than normal in getting the crop planted, but the weather since planting has been very favorable. There have been two cold spells of brief duration, but these have not been accompanied by too much moisture, and no rotting of seed pieces in the ground has been as yet indicated. Most of the planting was completed by the 20th of March. We understand that planting was much later than usual in North Carolina, and suspect that the North Carolina growers will be marketing a large percentage of their crop at the same time that the Virginia growers will market their crop this year. This will probably mean that a larger proportion of the crop in this area will go to the Government. We hear rumors in this area that South Carolina has less than one-half a crop. Since about 70 per cent of their plantings

were Sebago, most of which would have been harvested later than their Cobblers and at approximately the same time as our Cobblers in Virginia, our growers feel that prices here may be a little higher than they otherwise would have been.

The Norfolk and Southern Railroad is building a large packing shed at Euclid, Virginia, near Kempsville, on their railroad tracks to Virginia Beach for use by C. W. Capps, the largest potato shipper in this area. Mr. Capps has ordered five potato washers and driers for this shed. They will be installed and in operation at the beginning of our harvest season. There is a good possibility that two other washers will operate in the Norfolk section. We have heard that at least two washers and driers will be installed on the Eastern Shore of Virginia.

When the Euclid shed is completed, Mr. Capps will cease to operate his packing sheds in the lower part of Princess Anne County. It is rumored that the Norfolk and Southern Railroad will take up its tracks which now run into that section.

Last year about one million 10-pound bags of Virginia early commercial Irish potatoes were packed on the Eastern Shore. This year we look for a much larger quantity of potatoes to be packed in consumer-size packages. Mr. Capps intends to pack a sizeable proportion of his output from the large Euclid packing shed in 10-pound bags. By running his machines day and night, he will have a capacity of nearly 100 carloads per day, or about 20 cars for each washer and drier. The capacity of these washers and driers is one carload per hour. We understand that all of them are ordered from American Potato Driers, Inc., Raleigh, North Carolina. This company has more potato washers and driers in operation than all others combined in the east.—EDWIN W. CAKE.

WASHINGTON

The Director of Agriculture of the State of Washington recently established a bacterial ring rot quarantine. The conditions governing shipments of certified potatoes follow.

Each shipment must be accompanied by a quarantine certificate signed by a duly authorized inspector of the Department of Agriculture at the point of origin stating (1) that the seed potatoes are "certified" by and labeled in accordance with the procedures and in compliance with the rules and regulations of the official certifying agency; (2) that the certified seed potatoes are reported to be free from Bacterial Ring Rot; (3) every person importing certified seed potatoes shall notify the inspector in charge of inspection in any area regarding the place and time of arrival at point of destination where inspection may be made;

WANTED

BACK NUMBERS

American Potato Journal

Vol.	**1—No.**	**2-5-7-12**	**Vol.**	**9—No.**	**10**
"	**2—"**	**1-4-6-7-10-12**	"	**10—"**	**4-8**
"	**3—"**	**1-6**	"	**13—"**	**1**
"	**4—"**	**1**	"	**14—"**	**4**
"	**5—"**	**3-5-7-8-9**	"	**17—"**	**3**
"	**6—"**	**4-6-10**	"	**20—"**	**2**
"	**7—"**	**1-3-7-10-11-12**	"	**22—"**	**2**
"	**8—"**	**3-4-5-6-7-10**	"	**23—"**	**1-3**

Communicate with William H. Martin, New Jersey Agricultural Experiment Station, New Brunswick, N. J.

(4) every person transporting or importing certified seed potatoes shall make such potatoes accessible for inspection and shall so place them as to disclose their quality and condition; (5) any inspector may inspect any imported potatoes in transit or at point of destination; (6) certified seed potatoes found to be in the opinion of the inspector, infected with bacterial ring rot, shall be placed under "Quarantine"; (7) no person shall sell or offer for sale, move, allow or cause to be moved any such certified seed potatoes or remove such quarantine certificate without the written authority of an inspector; (8) the inspector shall notify the person concerned after placing the quarantine on the certified seed potatoes; (9) in doubtful cases samples of said certified seed potatoes shall be taken for a microscopic examination; (10) when on examination the certified seed potatoes are found to be infected with bacterial ring rot the inspector shall notify the "person" concerned. The "person" concerned shall cause such potatoes to be disposed of as the inspector may direct; (11) the inspector may give directions to the "person" concerned, or ultimate consignee as to the treatment of the container and equipment used in the handling and transporting of the certified seed potatoes; (12) if on examination the certified seed potatoes shall be found free from bacterial ring rot the inspector shall release said shipment concerned; (13) any person who shall violate or fail to comply with any rule or regulation adopted and promulgated by the Director of Agriculture in accordance with and under the provisions of this act shall be guilty of a misdemeanor, and for a second and each subsequent violation or failure to comply with the same rules or regulations, shall be punished by imprisonment in the county jail for not less than thirty days or more than one year, or by fine of not less than $100.00, or more than $1,000.00 or both such fine and imprisonment.

All employees of the Horticultural Division of the Department of Agriculture are hereby empowered and instructed to carry out the provisions of this order.

This order shall take effect on and after the 18th of March, 1948. —FRED J. MARTIN, Director of Agriculture.

PROVINCE OF ONTARIO

Fourteen resolutions were discussed and approved at a recent meetings of the Potato Section, Ontario Crop Improvement Association, held in Toronto. The organization is looked upon as a central clearing house for problems affecting potato production and marketing within the Province. There are active branches in every county and district in the Province, and official delegates representing each of 53 local associa-

tions attended the Provincial meeting, together with large numbers of growers and Departmental officials.

The subjects dealt with in resolution form were: Scab Control Research; Co-operative Plan for Central Storage; Pre-packaging and Marketing; Bacterial Ring Rot; Spray and Dust Program; Potato Certification Reports to Growers; Disinfection of Used Potato Bags; Variety Testing; Freight Assistance on Seed; Percentage of D.D.T. in Dusts; Standardization with Simplification of Commercial Products in Naming Spray and Dust Preparations; Strict Enforcement of Grade Regulations, and Appreciation.

The Resolutions Committee was headed by Stewart L. Page Barrie as *Chairman*. Other members were: A. V. Mason, Dundas; G. A. Hackett, Cochrane; Douglas L. Parks, Kemptville, and Clifford Wallwork, Stouffville.—R. E. Goodin.

THE NATIONAL ONION AND POTATO COMMITTEE

On the 24th of February, 1948, we asked the subcommittee on appropriations for agriculture to raise federal appropriations for breeding better potato varieties for our country from $50,600 per year to $100,600; and for breeding better onions from $15,380 per year to $25,380 per year.

It is well for the technical servants of any industry to understand that their support does not just grow on bushes. Some one must back their work constantly. The men making this particular part of the effort are: Above. From left to right,—Veril Baldwin, of Jackson, Michigan; David R. C. Smith, of Canastota, New York; Sam Kennedy, *Chairman,* Clear Lake, Iowa; Paul A. Xander, *Chemist,* the Wise Company; Representative John W. Gwynne, of Iowa, in charge

of the case in Congress; Earl V. Wise, Berwick, Pennsylvania, largest manufacturer of potato chips, who finds he cannot use Katahdins; A. R. Barham, Manager of export sales, the Bean Manufacturing Company; Godfrey L. White, Osceola, Arkansas; Leslie T. Wells, Riverhead, Long Island, New York; C. L. Fitch, secretary of the National Potato and Onion Committee; and Ed A. Trexler, Lenhartsville, Pennsylvania. These and other commercial people paid their own traveling expenses, and had contributed, since December, from their own pockets, mostly at the rate of $100.00 each, $1550.00 towards other costs for several years ahead.

The committee feels that no large valuable results, except great increase in knowledge, have been achieved in potato breeding, because the varieties already produced, although selling in great quantities because of their beauty, are of such poor table quality that they have reduced potato consumption and therefore threaten the future of the industry. The committee recognizes that such projects must be in the hands of research men and in close touch with educational institutions, because all existing knowledge must be the basis, and much new knowledge must be produced. The committee states, however, with considerable patience, that these projects, are not primarily research, but commercial effort for results of use to taxpayers. Increase of knowledge is not the end sought; it is only the necessary means to the business end. They again stated that the foremost objective should be a potato of high table quality, like the Cobbler, which is smooth and does not scab—all other objectives being minor to this one.

The arguments used at this hearing were: (1) that commercial success in potato breeding should be hastened; (2) that one member of the party alone was paying more federal income tax per year than the asking and that the industries were entitled to service; and (3) that although there were as yet no material benefits from the $2,000,000.00 and more, spent in 20 years on potato breeding, by the nation and the states,— yet one onion variety produced by these funds: the Excel, now maturing in south Texas, was returning a net increased profit over all the costs to date on both projects, so that the whole job is out of the red, with the vast profits still to be achieved.—C. L. Fitch.

ANNUAL MEETING

The annual meeting of the Potato Association of America, held at Chicago December 29-31, 1947, was one of the best attended in years. Abstracts of most of the papers presented were printed in the February issue of the Journal. The complete papers will appear in future issues.

STATEMENT FOR THE YEAR ENDING DECEMBER 15, 1947

TREASURER'S REPORT

RECEIPTS:

Balance from November 30, 1946	$1985.51
Annual Dues	3289.73
Sale of Advertising	4044.21
Sale of Reprints	427.61
Miscellaneous	99.47

TOTAL RECEIPTS $9846.53

DISBURSEMENTS:

Printing of Journal (13 issues)	$4178.95
Printing of Reprints	465.75
Mailing and Supplies	679.60
Miscellaneous	778.62
Secretarial Work	450.00
Stenographic Work	575.00

TOTAL DISBURSEMENTS $7127.92

Balance on hand Dec. 15, 1947, $2718.61.

Accounts Receivable: Advertising, Part of September and October. All of November.

Accounts Payable: Printing of November issue American Potato Journal.

REPORT OF THE AUDITING COMMITTEE

We, the undersigned Auditing Committee, have examined the books of the Potato Association of America and have found them to be correct.

E. L. NEWDICK, *Chairman*,
MELVIN ROMINSKY,
JOHN C. CAMPBELL.

The following resolution was adopted at the business session:

POTATO INTRODUCTION STATION RECOMMENDED BY POTATO ASSOCIATION OF AMERICA

The following resolution of the Potato Breeding Committee of the Potato Association of America was approved by the Association December 29, 1947, at Chicago:

"The Potato Association of America recommends: That a station be established for the maintenance and preliminary evaluation of wild and cultivated tuber bearing species of Solanum and closely related forms.

That the station be set up to serve the four regions and the United States Department of Agriculture as provided for in the Research and Marketing Act.

That provision be made to study the botanical and genetic relationships, as well as the morphological and physiological characteristics and economic potentialities of the material.

It is recommended that representatives of the Technical Committees of the four Cooperative regions and of the Bureau of Plant Industry meet to formulate a program and make recommendations for implementing the objectives stated above.

It is recommended that the Secretary of the Potato Association of America inform the four regional administrative advisers and the Chief of the Bureau of Plant Industry, Soils and Agricultural Engineering, of this action and that this resolution be printed in the American Potato Journal."

Potato Breeding Committee for 1947 of the Potato Association of America.

G. H. RIEMAN, *Chairman,*
JULIAN C. MILLER,
C. O. ERLANSON,
F. A. KRANTZ,
DONALD REDDICH,
F. J. STEVENSON, *Secretary.*

Dr. William Stuart and Dr. C. F. Clark were elected honorary members of the Association in recognition of their long years of outstanding service to the potato industry. Dr. E. V. Hardenburg, in presenting the award to Dr. Stuart, read the following citation.

DR. WILLIAM STUART

Dr. William Stuart, now residing in Tokoma Park, Washington, D. C., was recently retired as Principal Horticulturist of the United

States Department of Agriculture. For many years this organization which he helped to found enjoyed the benefits of his scientific training, his wise counsel and his effective leadership both at and between its annual meetings. We who have known him these many years especially miss him on occasions such as this. Few people have enjoyed as wide an acquaintance among both scientists and practical farmers throughout the world as has Doctor Stuart.

Born at St. Remi, Quebec, Canada, and receiving his elementary school education there, he early in life came to the United States to pursue his professional career. He received his B.S. degree at the University of Vermont in 1894, after which he served as assistant botanist from 1894 to 1901 and as associate horticulturist from 1901 to 1902 at Purdue University. From 1902 to 1909 he was Professor of Horticulture at the University of Vermont. Here he published several bulletins and scientific articles of primary interest to the science of potato production. Later his alma mater awarded him the honorory degree of Doctor of Science in appreciation of his contributions to science in this field. He added to his fund of knowledge by studying in Germany and in after years was invited to speak before the Royal Horticultural Society of London. Doctor Stuart's longest and most noteworthy period of service was as horticulturist and potato specialist in the United States Department of Agriculture from 1912 to 1935.

Doctor Stuart is probably most famous for his book entitled; "The Potato," which has been used as a text at many institutions in America and for his Classification of American Varieties of Potatoes. In collaboration with Dr. C. F. Clark of the U. S. Department of Agriculture he was indeed a pioneer in the field of potato breeding and the improvement of varieties.

We who are assembled at another Annual Meeting of the Potato Association of America take genuine pride in honoring Doctor Stuart and in conveying to him on this occasion our heartfelt esteem and our wishes for many more years of happy and productive life.

Dr. Donald Reddick then gave the following citation for Dr. Charles Clark.

Our Association does honor to itself in presenting this slight token of appreciation to a member who has done so much to further our common interest Doctor Charles F. Clark has given virtually all of his mature effort to a program of improvement of the queen of the vegetables and to this day continues his work though he has been officially retired and is privileged to enjoy the freedom of the contemplative life.

Doctor Clark is a Vermont Yankee in the very finest sense of that connotation. He earned his baccalaureate at the University of Vermont, and his doctorate at Cornell University. His association with Dr. H. J. Webber, who came to Cornell in 1908, undoubtedly started him on his life work. After a few years in the "west" where he inaugurated the work of the Greeley Station in Colorado, he migrated back east. For a time he spent his summers in Presque Isle, Maine, but later spent his winters in Washington.

In a big undertaking for the improvement of an important crop some one must do a great deal of spade work. Clark has done it for the potato and in consequence, the work of all of us has been made easier. I am sure all of us wish for him many more years of useful work.—DONALD REDDICK.

The following officers were elected for 1948:

President ....E. L. NEWDICK
Vice-President ....O. D. BURKE
Directors ....HAROLD MATTSON
W. A. RIEDL
W. D. KIMBROUGH

The following officers were appointed by the President:

Secretary ....H. A. REILEY
Treasurer ....JOHN C. CAMPBELL
Editor ....W. H. MARTIN

THE CONSTITUTION AND BY-LAWS POTATO ASSOCIATION OF AMERICA

As Drafted by the Exceutive Committee at New Brunswick, N. J.

June 2, 3, 4, 1947

RATIFIED DECEMBER 29, 1947

ARTICLE I — *Name*

The name of this organization shall be The Potato Association of America.

ARTICLE II — *Objective*

The objectives of this Association shall be to collect and disseminate scientific and general information relating to all phases of the potato industry, including research in the production, transportation, processing, marketing, and utilization of seed and table potatoes.

ARTICLE III — *Membership*

Section 1. Any person may become a member of this Association upon a payment of the Membership Dues fixed by the By-Laws. Such memberships may be annual, life, patron, or honorary.

Section 2. Voting privileges shall be limited to members in good standing.

ARTICLE IV — *Officers*

Section 1. The officers of this Association shall be President, Vice-President, Secretary and Treasurer.

Section 2. The duties of the officers shall be those customarily pertaining to these offices.

Section 3. Each officer shall hold office until the expiration of the term for which he is elected or appointed, and until his successor is duly elected or appointed and qualified.

ARTICLE V — *Executive Committee*

Section 1. The governing body of the Association shall be an Executive Committee, which shall consist of the contemporary officers, the retiring President, the Editor-in-Chief, and three Directors elected at the Annual Meeting.

Section 2. The President shall call meetings of the Executive Committee at his discretion, or upon written request of three of its members.

Section 3. The presence of a majority of the Executive Committee shall constitute a quorum for the transaction of business.

Section 4. All actions of the Executive Committee or Officers, must be authorized or approved by the Association at the Annual Meeting, except as specified in Article VIII, Sec. 3.

ARTICLE VI — *Election of Officers and Executive Committee*

Section 1. The President and Vice-president shall be elected for one-year term at the Annual Meeting. Three Directors shall be elected at the Annual Meeting in 1947: one to serve for one year, another for two years, and the third three years. Thereafter the Directors shall serve for a term of three years. Nominations for the officers and Directors shall be made by a Nominating Committee appointed by the President and additional nominations shall be accepted from the floor at the Annual Meeting, or as otherwise directed by the Executive Committee. Voting for the officers shall be by ballot, and a plurality shall elect.

Section 2. The Secretary and the Treasurer shall be appointed by the Executive Committee ordinarily for terms of two years, which shall not expire concurrently, and the Executive Committee may adjust the term or the date of assuming office to avoid this contingency.

Section 3. The President and the Vice-president shall assume office upon the final adjournment of the Annual Meeting at which they are elected.

Section 4. The Executive Committee may fill by appointment, any vacancy occurring within the prescribed term, such appointment to continue for the unexpired balance.

ARTICLE VII — *Meetings*

A general meeting of the Association shall be held annually, unless prevented by a National Emergency, at such time and place as the Executive Committee shall direct, unless otherwise ordered by the Association. Special or local meetings may be arranged at the discretion of the Executive Committee.

ARTICLE VIII—*Committees and Conduct of Association Business*

Section 1. The Executive Committee or the President shall appoint such standing and special committees as may be appropriate to conduct the business of the organization.

Section 2. Standing Committees are those whose functions include the general policies and internal relations of the organization, and its relations with other organizations. These Committees shall have a revolving membership, and shall submit an annual report to the Executive Committee at the Annual Meeting of the Association.

Section 3. The Executive Committee may undertake and carry out such special activities between Annual Meetings, including reference of questions to membership, by mail or special notices in the Journal.

ARTICLE IX—*Journal and Editorial Board*

Section 1. The Official publication of the Association shall be the AMERICAN POTATO JOURNAL.

Section 2. The Executive Committee may appoint an Editor-in-Chief and an Editorial Board as prescribed in the By-Laws. A business Manager may also be appointed, who may be the Secretary or the Treasurer, at the discretion of the Executive Committee.

Section 3. The Executive Committee may authorize the Editor-in-Chief, or other officers, to employ such assistants as may be necessary for the proper conduct of their work.

ARTICLE X—*Funds*

The control of Funds of the Association received from all sources shall be vested in the Executive Committee, to administer through the appropriate fiscal officers and committees. An audit of the receipts and disbursements shall be made annually by an auditing committee, or at the discretion of the Executive Committee by a certified public accountant. The reports of the Treasurer or other fiscal officers, together with that of the Auditing Committee, shall be published annually, in the official publication.

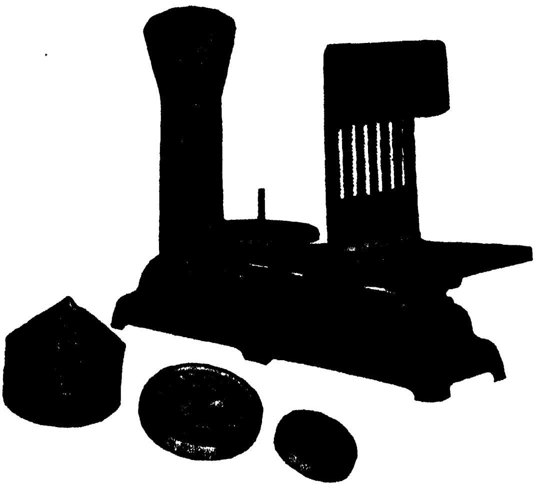
ARTICLE XI—*Method of Ratification and Amendment*

Section 1. This Constitution shall become effective upon its ratification by the 1947 Annual Meeting, and shall supercede the original Constitution and all amendments thereto.

Section 2. This Constitution may be amended at any Annual Meeting of the ASSOCIATION, or at any regular meeting called for this purpose, provided that any proposed Amendments be approved by the Executive Committee, and that it receive the affirmative vote of at least two-thirds of the members voting at a regularly scheduled business session.

What Wholesalers and Retailers say about Pre-packaged Produce...

In a prepackaging survey just completed by FOOD TOPICS both wholesalers and retailers of produce report sales increases ranging from 10% to 150% in this type of merchandise. They say (1) prepackaging facilitates self service (2) identifies produce by brand (3) reduces freight cost (4) cuts waste and spoilage (5) materially increases sales. It's the way to sell potatoes too when they are packaged the exact weight way. If you sack in consumer bags, use EXACT WEIGHT Scale Model 708-P (illustrated) built specially for potato growers and distributors. Whatever weight bag you package there is an EXACT WEIGHT Scale for the job. Write for details for the size bag you package.



EXACT WEIGHT Scale Model 708-P—Features: Special commodity holder, tilted and equipped with guard to hold bags . . . dial 6" wide, 1 lb. overweight and underweight by 4 oz. graduations and in direct line of operator's vision . . . nonbreakable dial glass . . . short platter fall for speed of operation . . . Capacity to 15 pounds.

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BY-LAWS

1. Membership and Dues

A. *Members*

The individual annual membership fee shall be Two Dollars ($2.00), including a subscription to the American Potato Journal.

The Executive Committee may authorize group memberships at a reduced rate ,as set from time to time by such committee.

B. *Life Members*

Life memberships may be granted to any person upon payment of Thirty-five Dollars ($35.00).

C. *Patron Members*

Patron memberships may be granted to any person (or firm) upon payment of One Hundred Dollars ($100.00).

D. *Honorary Life Members*

Honorary life membership may be granted at the discretion of the Executive Committee to individuals who have contributed to the interests of the potato industry in an outstanding manner. Not more than two (2) new honorary members shall be elected each year.

2. American Potato Journal

A. *Editorial Board*: The policies governing publication of the Journal shall be vested in an Editorial Board, consisting of an Editor-in-Chief, and such associate editors as may be selected at his discretion. The Editorial Board shall have authority to reject any paper deemed unworthy of publication in the Journal.

B. The Editor-in-Chief may receive compensation for his services as determined by the Executive Committee.

C. *Subscriptions* and *Back Numbers*: Subscriptions to the American Potato Journal for institutions and non-members shall be $2.00 per year. The sale and price of back volumes or numbers shall be determined by the Editor-in-Chief with the approval of the Executive Committee. Requests to supply lost copies without charge must be made within sixty days from date of issue.

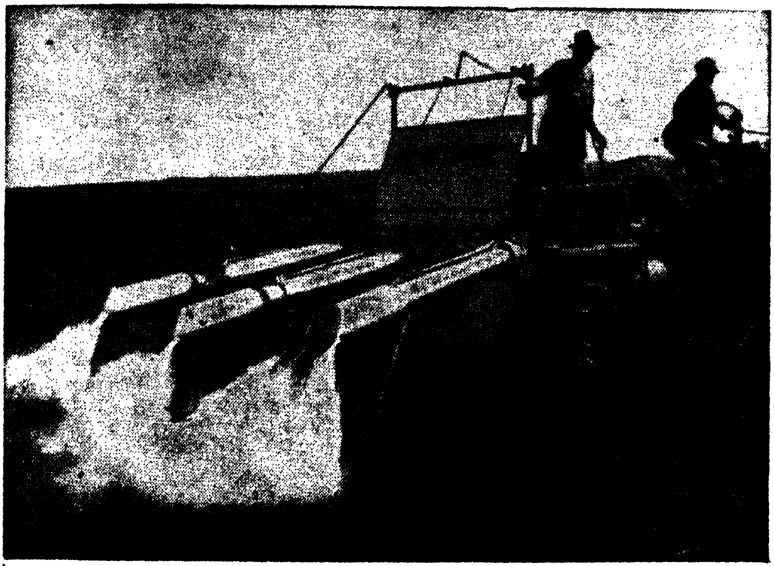
3. Duties of Officers

A. The President shall preside at business meetings and general sessions of the Association, and serve as chairman of the Executive Committee.

B. The Vice-president shall assume the duties of the President in his absence or incapacity and shall serve as a member of the Executive Committee.

C. The Secretary shall keep the records of the Association at all of the regular or special meetings, and a record of meetings of the Executive Committee, shall make the necessary arrangements for the annual or other meetings at the direction of the Executive Committee, and shall serve as a member of the Executive Committee.

D. The treasurer shall keep, or cause to be kept, full and accurate accounts of receipts and disbursements in books belonging to the Association and shall deposit all moneys and other valuable effects in the name of and to the credit of the Association in such depositories as may from time to time be designated by the Executive Committee. He shall disburse the funds of the Association as may be ordered by the Executive Committee, taking proper vouchers for such disbursements, and shall render to the President and Executive Committee whenever they may require it, as well as to the Annual Meeting of the Association, an account of all his transactions as Treasurer and of the financial condition of the Association.



4. Duties of the Executive Committee

The Executive Committee shall act for the Association in the *interim* between Annual Meetings; shall fix the date of the Annual Meeting; and shall consider matters of general policy in the Association and present their recommendation at the Annual Meeting. The Executive Committee shall meet prior to the Annual Meeting of the Association, or at other times approved in Article V, Section 2, of the Constitution.

5. Quorum

Ten members of the Association shall constitute a quorum for the transaction of business at a regularly called annual or special meeting, of which at least thirty days' notice shall have been given to members.

6. Committees

A. *The Program Committee*: This Committee shall consist of the Secretary who shall act as chairman, together with the other officers of the Association. This Committee shall have full authority over the scheduling of sessions and demonstrations, and the allocation of papers. It shall receive titles and arrange the program of the Annual Meeting, arrange symposia, accept or reject titles and may invite non-members to participate.

B. *Nominating Committee*: This Committee shall consist of three members at large appointed by the President. Their duties shall consist of presenting a list of nominees for the various offices at the following annual or regular meeting of the Association. In selecting nominees an effort shall be made to provide representation from the major fields of membership of the Association.

C. *Membership Committee*: This Committee shall be appointed by the President and its duties shall be the promotion of membership in the Association. The Secretary and Treasurer shall serve on this Committee.

D. *Auditing Committee*: This ommittee shall be appointed by the President to audit the books of the Association, and report at the Annual Meeting.

E. *Committee for Local Arrangements*: This Committee shall be appointed by the President and be combined with the Program Committee, and shall work closely with the Program Committee in making local arrangements for the Annual Meeting.

F. Other committees may be appointed by the President, as deemed advisable, to study and report on other special fields of activity associated with the potato industry.

7. Miscellaneous

A. The fiscal year of the Association shall be from December 1 to the following November 30.

B. *Liability*. The liability of each officer and member shall be limited to the amount of his dues for the current year.

8. Amendments

These By-Laws may be amended by a majority vote at any regular meeting or by a majority vote of the members voting in a ballot by mail.

American Potato Journal

PUBLISHED BY

THE POTATO ASSOCIATION OF AMERICA

NEW BRUNSWICK, N. J.

WEED CONTROL IN POTATOES WITH 2,4-D

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AND

R. W. Shuel[2]

Department of Field Husbandry, Ontario Agricultural College, Ontario, Canada

In recent years, selective chemical weed killers have been used extensively to control weed growth in crops. Crafts, A. S. (*1*) enumerates the factors governing the selective action of different types of chemical herbicides. These include, in addition to such morphological features as leaf structure and arrangement, properties apparently inherent in the plant. There are three groups of selective herbicides: the dinitro compounds, the selective light oils, and the growth-regulating compounds.

The possibility of using synthetic growth-regulating compounds in a herbicidal role was first investigated in England in 1942, and in the United States in 1944. Since then more than a thousand such compounds have been tested at Camp Detrick, Maryland (*5*). Of these 2,4-

[1]Agricultural Scientist.
[2]Research Fellow.

dichloro phenoxyacetic acid, or 2,4-D, in various formulations including the methyl, ethyl, and isopropyl esters, amine salts and sodium salt, has received the most attention. Its use has been widespread in the control of turf and lawn weeds since 1946; it has been the subject of constant experimentation in weed control in crops, particularly the cereal grains, which appear to be comparatively resistant to its action.

A comprehensive list of weeds and crop plants and their reaction to 2,4-D is included in the Report of the North Central States Weed Control Committee, 1946 (*4*). Potatoes are herein reported as intermediate in their resistance to 2,4-D. Ennis *et al* (*2*) studied the effects of several growth regulating compounds on Irish potatoes, and found that 2,4-D applied at the rate of 8 mgms. per 6" pot had no adverse effect on Irish potatoes. They suggested the use of 2,4-D to control weeds in potato crops.

It is generally accepted that cultivation of the potato crop should cease when the plants are in full bloom. Any tillage after this time results in root pruning and consequently a reduction in yield. However, under Ontario conditions many broad-leaved annuals if not removed later in the season grow to a gigantic size. To destroy these weeds in the potato rows requires hand hoeing—an expensive type of cultivation. The presence of these weeds, particularly in the potato rows, gave rise to the idea of using a selective herbicide.

Materials and Methods

1946—Small scale preliminary tests were conducted to determine the response of potatoes to 2,4-D. The plots were sprayed with aqueous solutions of the triethanolamine salt of 2,4-D at concentrations of 500, 750, and 1,000 p.p.m. at rates equivalent to 0.8, 1.2, and 1.6 pounds of the free acid per acre. Day temperatures immediately before and after spraying ranged betwen 75° and 85°F; night temperatures, between 50° and 60°F. Twenty-four hours after spraying 0.83 inches of rain fell.

A slight yellowing of foliage accompanied by epinasty of the new growth resulted from the spray. Within three weeks the sprayed plants had recovered completely. Statistical analysis revealed no reduction in yield or in quality of the tubers. It was decided, therefore, to carry out more extensive tests in 1947.

1947—Tests were carried out on land which possessed a well-established weed population. A crop of winter rye fertilized at the rate of 500 pounds per acre of 4-8-10 fertilizer was plowed under in preparation for the potato crop. Katahdin potatoes were planted on the 11th of June with an application of 1,000 pounds per acre of 4-8-10 fertilizer.

Plots consisted of six 20-plant rows in 5 randomized replicates. For yield tests, rod-length sections of the four middle rows were taken.

The randomized plots received the following treatments:—

A—Cultivation up to blossoming + ridging + spraying on the 18th of July with an aqueous solution of the triethanolamine salt of 2,4-D at 750 p.p.m., 1.2 pounds free acid per acre. No cultural weed control after ridging.

B—Cultivation up to blossoming + ridging + spraying on the 18th of July at 1000 p.p.m., 1.6 pounds free acid per acre. No cultural weed control after ridging.

C—As for A, but sprayed on the 29th of July.

D—As for B, but sprayed on the 29th of July.

E—Cultivation + ridging + hoeing after ridging.

F—Pre-ridging cultivation, but no ridging and no subsequent weed control.

A 4-gallon knapsack sprayer developing a pressure of *circa* 50 pounds was used in these experiments.

At the time of the first spraying, the 18th of July, the potatoes were about 12 inches in height. The temperature was 78°F. About three hours later a shower of 0.19 inches of rain fell which caused the temperature to drop. The mean temperature on the following day was 59°F. After this date, normal July weather prevailed—day temperatures of 75° to 80°F; night temperatures 50° to 60°F. There was a heavy infestation of the following annual weeds, mostly 6″ or under in height: *viz.* Lamb's Quarters, (*Chenopodium album*); Pigweed, *Amaranthus, retroflexus*); *Ragweed,* (*Ambrosia artemesiifolia*); and Foxtail, (*Setaria viridis*).

By the 29th of July the weeds in unsprayed plots were as high as the potatoes. Temperatures at this time were normal, and no rain fell.

The results of these sprayings were striking. No damage to the potatoes could be detected. All weeds, except the resistant Foxtail, showed typical symptoms of injury within a few days of spraying. On the 1st of October, when the potatoes were harvested, sprayed plots were still completely free from the broad-leaved weeds.

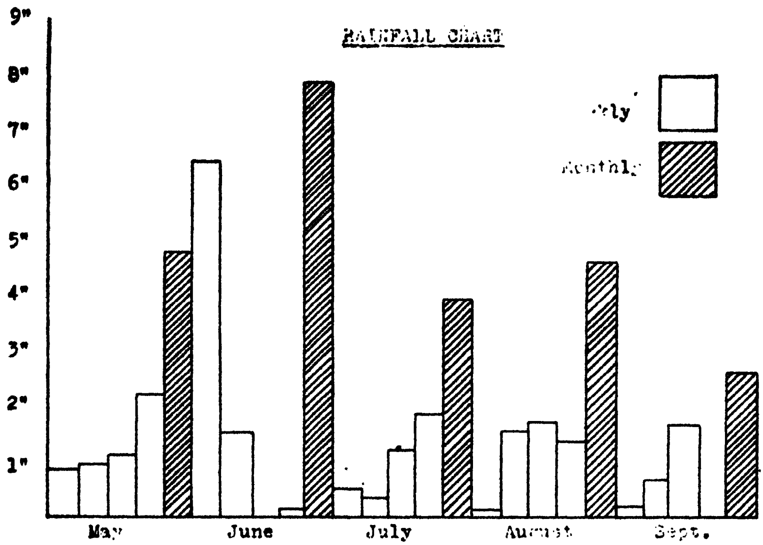
An analysis of variance and co-variance was made on plot yields. Specific gravity and cooking tests were conducted on composite samples after the potatoes had been stored at room temperature for one month. The results of these determinations are given in table I.

Large Scale Tests

The results of the plot test were so encouraging that it was decided to spray a 4-acre block of Katahdin potatoes, and a small section of

TABLE I.—*Katahdin Variety*

Treatment	Mean Yield Bus. per Acre	Mean Yield of Treatments Expressed as Per cent of General Mean	Per Cent No. 1 Potatoes	SPECIFIC GRAVITY TESTS		COOKING TESTS			
				Dry Matter	Starch	Appearance	Mealiness	Flavor	Total
A	214.06	107.2	85.6	18.3	14.5	16	34	33	83
B	184.62	92.5	85.2	18.3	14.5	17	35	33	85
C	218.24	109.3	90.3	18.3	14.5	15	30	33	78
D	201.59	101.0	88.7	18.3	14.5	17	29	32	78
E	187.04	93.7	87.5	18.3	14.5	18	37	31	86
F	192.54	96.4	87.5	17.4	13.9	15	31	34	80
G. M.	199.68								


9"
8"
7"
6"
5"
4"
3"
2"
1"
June
July

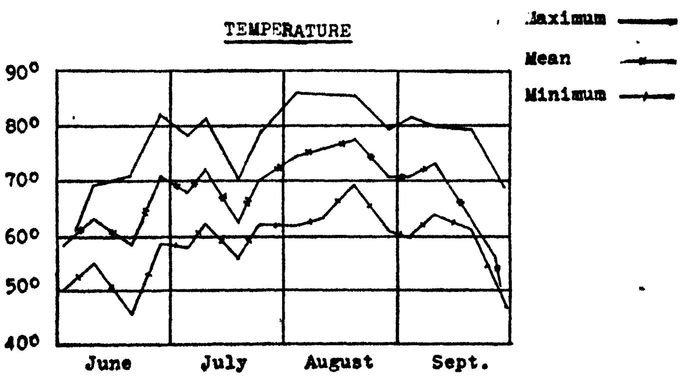

TEMPERATURE
Mean
Minimum
90°
80°
70°
60°
50°
40°
June
July
August
Sept.

FIG. I. Section of field of Katahdin potatoes one week after spraying with 2, 4-D at 750 p.p.m., 1.2 pounds of the free acid per acre. Weed on left showing typical 2,4-D injury is Pigweed (*Amaranthus retroflexus*); weed on right, Lamb's Quarters (*Chenopodium album*). No injury to potato foliage is evident.

FIG. 2. Photo of section of Irish Cobbler potato field taken three days after spraying with 2,4-D at 750 p.p.m., 1.2 pounds of the free acid per acre. Injury from spray is indicated by chlorotic foliage in the middle. Vines in background were not sprayed.

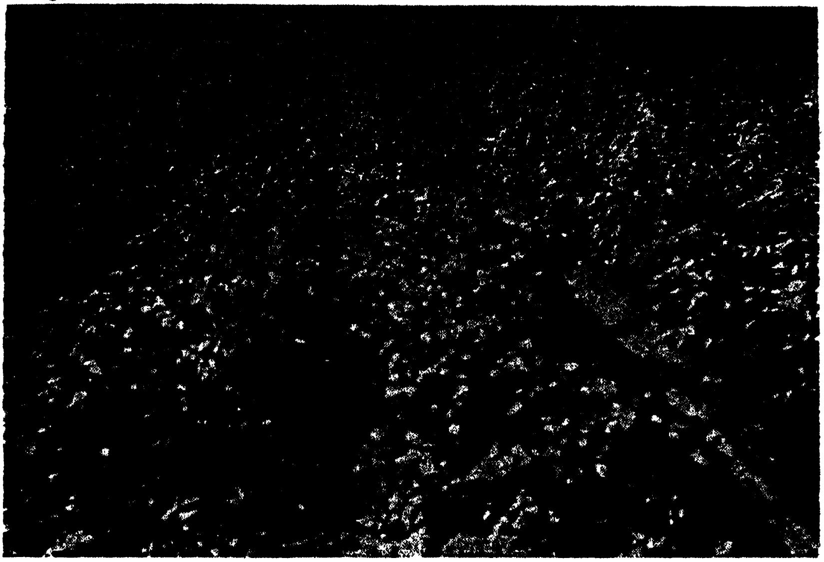


FIG. 3. Field of Katahdin potatoes taken one week after spraying. Left—Sprayed with 2,4-D at 750 p.p.m., 1.2 pounds of the free acid per acre. Right—Unsprayed.

Irish Cobbler. This was done on the 9th and 13th of August, when the potatoes were in bloom. Weeds at this time stood well above the potato plants. An ordinary potato sprayer developing 250 pounds pressure was employed. An aqueous solution of the triethanolamine salt of 2,4-D was applied at the rate of 1.2 pounds of the free acid per acre.

OBSERVATIONS AND DISCUSSION

Within two days of spraying all broad-leaved annual weeds in the sprayed block showed symptoms of 2,4-D injury. A week after spraying no weeds were visible above the potatoes. (See Fig. 3) The completeness of weed control was somewhat surprising, inasmuch as weeds are generally regarded as developing an increased resistance to 2,4-D spray as they approach maturity.

Response to 2,4-D was noticeably different in the two varieties. Katahdin and Irish Cobbler. There was no damage to the vegetative portions of the Katahdin, although the flowers were destroyed. The foliage on the Cobbler, however, turned yellow within 3 days after spraying, and the plants died within 10 days. This differential response might be attributed either to varietal characteristics or to the stage of maturity.

The Cobbler, an early maturing variety, was within 2 weeks of maturity when sprayed; Katahdin lacked 4 weeks of being mature.

The Cobbler variety, in 1947, exhibited similar injury to that suffered by the Katahdin in 1946, but to a much greater degree. In the 1946 plots the injury consisted of a mild chlorosis and epinasty of the younger leaves with subsequent recovery. There was no decrease in yield. The Katahdin variety was sprayed at the same stage of growth in both seasons. The reason for this difference in response could be seasonal. Conditions of temperature and moisture which are favorable to photosynthesis appear to favor effective action of 2,4-D (*6*) whereas very low temperatures retard its herbicidal action (*3*). Weather conditions in both 1946 and 1947 should have been favorable to rapid action of 2,4-D. The results of the two years' tests indicate that further work on varietal and seasonal response would be of benefit before general recommendations can be made.

Results of Analysis of Variance on Small Plots (Table 1.)

The coefficient of variation of the experiment is very high, 18.4 per cent; hence no significant differences in yield between treatments are apparent. It cannot be stated, therefore that any treatment was definitely beneficial or detrimental. However, it is to be noted that mean yields of plots sprayed at 750 p.p.m. were higher than the general mean. Those receiving no spray were below the general mean. The fact that the mean yield of plots in which weeds were allowed to grow unchecked was higher than the two means of treated plots is significant. There was a plentiful supply of moisture throughout the growing season, and water should not have been a limiting factor in the growth of either potatoes or weeds; an adequate supply for both was probably available. Similarly competition for nutrients should not have been serious, in view of the application of fertilizer. The inference might be made that under fertility and moisture conditions obtaining in this experiment, the presence of weeds did not significantly reduce the yield of tubers.

Specific gravity and cooking tests revealed no wide variation in quality among the potatoes which received the different treatments.

Cost of Spraying

These tests show that the cost of materials for spraying an acre of potatoes was approximately \$3.20; and the cost of hoeing an acre of potatoes with a similar infestation of weeds, approximately \$9.00. The cost of application would be completely eliminated if the 2,4-D could be incorporated in the regular spraying or dusting program.

Summary

(1.) 2,4-D spray, applied at the rate of 1.2 pounds of the free acid per acre, gave excellent control of the annual broad-leaved weeds in potatoes.

(2.) No detrimental effect on yield or quality of tubers of the Katahdin variety was found in either 1946 or 1947.

(3.) A difference in varietal and seasonal reaction to 2,4-D was apparent. In 1946, the Katahdin variety showed damage to floral parts and mild chlorosis of the new growth. These plants recovered from the chlorosis. In 1947, the Katahdin variety showed damage to floral parts, but no damage to foliage, whereas the Cobbler variety developed severe chlorosis, and matured without indication of recovery.

(4.) The cost of spraying would be decreased if the 2,4-D could be incorporated in the regular potato sprays or dusts.

(5.) Further work on varietal response is necessary before general recommendations for the use of 2,4-D in weed control in potatoes are made.

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WHAT'S AHEAD FOR THE POTATO INDUSTRY

PORTER R. TAYLOR[1]

Fruit and Vegetable Department, American Farm Bureau Federation, Washington, D. C.

The potato industry is at a cross road in its development due to the gradual but steady decline in per capita consumption and the rapidly rising increase in per acre crop yield. In addition, the industry is affected by the many influences related to the end of the war as well as by the special conditions resulting from the fact that potatoes have served as a "guinea pig" in the operation of the Steagall price support program. Thus an analysis of the trends affecting this important commodity must include important longtime factors as well as those of a more temporary character.

Time will not permit considering many important phases which should be included in any complete discussion of this subject. Among these we might include a wide variety such as certified seed, fertilizers, insecticides, fungicides, improved production practices and many other related subjects. Without ignoring the importance of these factors on the broad future of the potato industry, it will be necessary to limit this discussion to a few of the more important features which relate directly to the economic phases of the potato problem.

Probably the most important single question which should be of concern to potato growers is "How large a consumer market do we have for our product?" Producers cannot ignore the fact that the white potato is one of the few fruit and vegetable commodities which is experiencing a steady decrease in consumption per capita. The average per capita consumption during the five years from 1930-1934 was 138 pounds, from 1935-1939 was 131 pounds, and from 1940-1944 was 129 pounds. The revised consumption for 1946 was 122 pounds and the estimated figure for the current season is 125 pounds.

On an "apparent consumption basis" it would appear that from 285 to 290 million bushels will be sufficient to meet domestic consumption requirements, to which should be added 15 million bushels for exports and normal processing and from 35 to 40 million bushels for use as seed for the succeeding crop. This should indicate that the actual quantity of merchantable potatoes needed to meet present commercial requirements will vary from 335 to 345 million bushels, or an average of about 340 million bushels.

[1]Director.

[2]Presented at the Annual Meeting of the New Jersey State Potato Association, Trenton, N. J., Jan. 29, 1948.

Now let us check this figure from another approach, that of actual total production less government purchases for support purposes, which indicate the volume of production needed to meet commercial requirements.

Crop of	Total Production (Million Bushels)	Government Purchases[1] (Million Bushels)	Production for Commercial Uses. (Million Bushels)
1943	465.0	24.9	440.1
1944	383.1	3.1	380.0
1945	418.0	27.5	390.5
1946	484.2	98.4	385.8
1947	384.4	21.0[2]	363.4

[1]Purchases plus other quantities handled.
[2]To January 17, 1948.

We all recall that the support program for the 1943 crop season was not successful in maintaining the support price and that much of the surplus was not removed from the market that year. However, it is most interesting that during the four seasons since the production needed for commercial use has varied from 363 to 390 million bushels, approximating an average of close to 380 million bushels for each of the four seasons.

From these rather simple calculations it would seem that we might reach the conclusion that *current market requirements* for consumption, exports, and seed approximate 340 million bushels and that an *average production* including shrinkage of about 380 million bushels has been used during each of the past four seasons to furnish such market requirements. Either of these figures would seem to be a fair measure of the present market for potatoes in the United States.

Perhaps next in importance is the question, "How many potatoes are we growing?" The figures quoted above give the total production for each of the past five seasons. Now let us consider what they represent from the standpoint of acreage and yield per acre.

Undoubtedly, the most startling facc disclosed by these figures is the fact that the yield per acre of the past two seasons has been 50 bushels above the ten-year average, and more than 40 bushels above any other year except 1945. If the upward rise of per acre yield attained

Average	Harvested Acreage (Thousands)	Yield (Bushels)	Total Production (Million Bushels)
1936-1945	2,862	132	376
1941	2,711	131	356
1942	2,706	137	370
1943	3,331	140	465
1944	2,922	131	383
1945	2,696	155	418
1946	2,599	186	484
1947	2,112	182	384

during the past three years continues and becomes permanent, then we must anticipate substantial changes in the potato production picture.

Although the national acreage goal for 1947 was 2,517,000 acres, the actual acreage harvested was estimated to be 2,112,000 acres. Yet this acreage, the smallest harvested since 1881, was sufficient enough to produce a surplus of at least 21 million bushels. If the average yield for the entire country should rise to 200 bushels per acre, as some persons are predicting, then it would be necessary for the acreage to drop to approximately 1,900,000 acres, or about 10 per cent below the 1947 acreage.

With the end of the Stegall price support only a few months off unless Congress takes action, growers need to face realities and to lay plans now to maintain the potato industry on an even keel and to keep it there. The Steagall Amendment was enacted to protect growers who responded to the nation's wartime need against serious price declines during the war or post-war periods if an excess supply resulted. Throughout this period the country had ample supplies of potatoes and the 1943 and 1946 crops were of record volume. The 1947 acreage was largely limited by allotments to each grower, which it was necessary to adhere to if the grower was to be eligible for the support program. A similar program is expected to be in effect in 1948.

Even though these programs have been subject to some criticism in the press, those who have done so have failed to appreciate that it

was far better to be concerned with problems of surplus disposal rather than those of shortage which the potato industry has not experienced since the 1941 crop. Obviously, the Steagall programs designed for war production cannot be expected to be continued during peacetime and so the industry should be considering a more permanent basis for meeting such situations in the future.

First in importance would seem to be the stabilization of acreage at that amount which will produce an adequate supply with as little surplus as possible above the actual needs. High yields per acre should be encouraged so that low cost production will be secured. Every effort should be made to avoid the alternate fluctuations of acreage which have been so common in the past and have been one of the causes of periods of surplus and scarcity of this commodity. If the increase in per acre yields continues, it will be necessary to make further reductions in acreage unless there is a considerable increase in consumption.

Next in importance should be to increase potato consumption. A lowering of price to consumers will not result in materially increased consumption of white potatoes, because the demand for potatoes is inelastic except at extremely low or high price levels.

The most promising method for increasing consumption would seem to be a substantial improvement in the quality of the potatoes marketed. Although there is great need for further research on this subject, it seems that consumption could be enlarged considerably if the consumer is offered a good quality of potatoes at all times, which obviously is not the case now.

The substantial shift in certain producing districts to red varieties emphasizes the demand for a better quality of potatoes. At least a portion of the shift of acreage to the irrigated areas from other producing districts reflects the same desire for superior potatoes, especially those which are well adapted for baking purposes. There is much to be done to provide new varieties which will be more suited to production and consumption needs.

The industry must do more in advertising and sales promotion if it is to widen its consumption outlets. This will probably be more difficult in the case of potatoes than with most commodities of a similar character, although the product has many selling points such as the considerable quantity of Vitamin C which is contained in the average serving of potatoes.

Another most necessary step is to improve potato grading. After thirty years of use there is still need for improvement in the actual use of the U. S. grades. The recent establishment of optional U. S. grades

for consumer packages should afford an opportunity to carry out a practical test of these more strict grades with consumer packages.

However, there is still much to be done before the industry can claim that it is doing a good job of grading. In fact, in some areas the reverse is actually the case. During the past season some producers in one state protested against the use of the U. S. grades in a marketing agreement program because it prevented them from shipping the cull potatoes of which they had an abundance. It hardly need be stated that the quotations on potatoes from that state have been among the lowest in the country.

Washing and brushing are closely related to grading, although they technically are not necessary to meet the primary grade requirements. However, they do improve the appearance and salability of the stock materially. Perhaps the best indication of the value of washing and grading can be emphasized by the fact that such preparation brought South Carolina potatoes to a competitive price basis with California in the New York market last spring.

After doing all that is possible to stabilize acreage and to grow the varieties desired by consumers, Nature will still have much to say with regard to the size of the final crop and whether any surplus may prevail. Once the crop is produced, the sensible procedure would seem to be to determine what proportion might be considered to be surplus in a producing district, and to take steps to keep that unneeded volume off the market.

The most permanent and practical method for such actions would seem to be the development and use of a marketing agreement program which would permit the industry to withhold the lower grades from market when they are not needed. Although such a program is conducted under government supervision, it is actually administered and operated by the industry itself. One special advantage is that regulations recommended by the industry committee can be varied from time to time and thus have flexibility which permits adjustment to meet changed conditions. Enforcement is handled by the Department of Agriculture through the Department of Justice. Since the Marketing Agreement Act of 1937 was established by Congress and the basic court decisions supporting it were rendered, there has been little delay in securing adequate enforcement in the Federal Courts.

After fully considering all possibilities which might be utilized in solving the potato problem, representative groups within the American Farm Bureau Federation recommended that the regional marketing agreement approach be used as a long-time program for potatoes, with the addition of the acreage allotment method during the remainder of

the Steagall period when the 90 per cent support provision was in effect.

In addition to its advantage with regard to the restriction of grades and sizes, a marketing agreement is authorized to include an industry program for the handling of surpluses or for diversion to other outlets. Thus, when desired it can provide the machinery for improving the grade of product offered to the market, for withholding the balance of the crop from marketing, and can provide for its diversion to other outlets under a surplus program, all under industry rather than government operation.

Having recommended such marketing agreement programs for potatoes, the American Farm Bureau Federation has actively endeavored to get them organized and in operation. In addition to the previous programs, new ones have been added so that the present situation is as follows: Marketing programs are now in effect and can be operated as the industry desires in Michigan, Wisconsin, Minnesota, North Dakota, Colorado, and Idaho. A program applying to Oregon and northern California can be restored for next season in that territory, and a new one is about ready to be formally established in South Dakota. Hearings have been held applying to Nebraska, Wyoming, South Carolina, North Carolina, Virginia, and Maryland and a substantial proportion of these areas is expected to complete agreements before the 1948 crop is marketed. If so, this will leave southern California, Washington, and the northeastern states as the only important areas which have not taken definite steps for 1948. The latest information is that Maine is actively considering an agreement at this time for the 1948 crop. If so, the only important intermediate and late-producing area which is not endeavoring to work out such a marketing program will be New York, Pennsylvania, New Jersey, and adjacent states.

Some consideration has been given to the development of a marketing program for this area but without tangible results to date. Several reasons have been stated for not establishing such a program. Among these arguments is that such a program cannot be operated close to market although it is a matter of official record that in 1946 New Jersey shipments were destined for 25 states in addition to New Jersey ranging from Maine in the northeast to Alabama, Tennessee, Kentucky, Illinois, and Wisconsin on the west, whereas Long Island shipments went even further into Louisiana, Mississippi, Oklahoma, and Missouri.

Another reason stated is that grade regulations cannot be effectively used in a territory where potatoes are harvested as early as possible. At the most, this would only be plausible at the time of the initial digging and would cease to be of importance if agreements prove workable in the southern states. In quite a few commodities the results

achieved through agreements have been to require products to meet minimum standards of maturity for the common good of grower, distributor, and consumer. It is possible that experience might prove that every one would benefit if the harvest of "feathered" and immature potatoes were stopped as has been found with other commodities.

Another reason given for unwillingness to attempt a marketing agreement is the fact that enforcement would be more difficult close to consuming centers. That is true, but if the industry in the commercial shipping areas of these states really wants to make a marketing agreement work they can do so because they will be the ones who will profit from it.

A still further reason frequently suggested is that such a program should be acceptable if all parts of the country would be required to comply. Not only is the provision of the law regional in character, but the economic facts are the same. For example, at the present time there is a very short supply of potatoes in the western part of the country where even culls are being marketed at good prices while it is necessary to support the price of U. S. No. 1 stock in Maine. Next year the reverse of this situation may be experienced. A further reason often given is that all growers should be required to comply whether they are of commercial or non-commercial character. Actually, commercial growers are the only ones who have a financial stake in the future of the potato business and they are the ones who will benefit primarily by grade restrictions. In addition, it will be feasible to police a few commercial counties in a state where potato production is a major activity, although it would be difficult, if not impossible, to cover a wide area where it is a minor crop.

The effectiveness of a grade restriction program will be improved if facilities are available to process lower grade and surplus potatoes into other products such as starch, livestock feed, flour, alcohol, etc. This would especially be true if outlets might be developed which would provide a financial return in excess of the cost of processing.

Research is now in progress which it is hoped may result in the more efficient manufacture of by-products. The most recent report of the Bureau of Agricultural Chemistry just issued contains the following tentative conclusions on this work: "Correlation of available data on the feeding value of dried potatoes for cattle, sheep, and hogs showed that, in general, they can be considered to have a value of about nine-tenths that of No. 2 yellow corn. On this basis, and at an estimated cost of $23 per ton for processing the potatoes, the net income from sale of dried potatoes for feed in competition with No. 2 yellow corn at $2

a bushel would be enough to permit the payment of about $8.75 per ton for raw potatoes delivered at the factory and to give a return of 10 per cent on the investment."

If this development is successful, it should do much to improve the grade of potatoes placed on the commercial markets of the country. In the meantime, growers and shippers have a direct interest in providing facilities for such processing. In addition, to the direct advantage of improving their own pack, they will be doing their part in removing the surplus or lower grades from the market and making a more permanent and stable price structure. May I call your attention to the fact that the fruit industry has done this many years ago, as has certain portions of the vegetable industry. But only in Maine, Idaho, and a few other local areas do we find that the potato industry has developed such facilities for its own use, which it should have done long ago.

One other step which the industry must take is more aggressive merchandising, especially when supplies are large. If the present decline in per capita consumption can be stopped and turned to an expansion, it will immediately increase the portion of the crop needed for food purposes. Each pound of per capita increase reflects a national total of 2-⅓ million bushels, so that an increase of 4 pounds would approximate an increase in market outlet of 10 million bushels.

Few persons within the industry would contend that a good job of merchandising has been done with this commodity. The failure to grade properly, to sell aggressively, and to give consumers a dependable and uniform product at all times need to be corrected. The grower and the shipper must recognize that it is their primary responsibility to produce, grade, and package potatoes which will encourage repeat sales and increased consumption. If and when they have done this, then, and only then, do they have a right to insist upon full cooperation by wholesalers and retailers in aggressive merchandising.

There should be a recognition by the industry that most of the shift in production has been to areas such as Maine, Idaho, Colorado, and southern California which have been paying particular attention to the grading, marketing, and advertising of their product. They have been able to expand in part because they have done a better job of selling than the older producing districts. But even these areas will have increased difficulties in the future because of the higher freight rates which now prevail and which are likely to continue for some time. These increased costs will be an additional problem to them, but will be an added advantage to producers located closer to market if they have the business judgment to make the most of their opportunity.

Instead of criticising the success of the more distant areas, those nearer to market should follow in their footsteps, because only through improved quality and aggressive merchandising in all parts of the country can the industry expect to solve its problems and end its present difficulties.

The retailer has an important place in this part of distribution. First, potatoes embrace about 18.5 per cent of his total volume of produce sales in dollars. Most retailers are anxious to increase their total sales. But when we complain about the small sizes and cull potatoes which too frequently are found in the grocer's potato bin, we must remember that some one failed to grade these out at shipping point, placed them in a sack, and started them on their way to market. Although he may have thought that he gained on the transaction individually, the whole industry actually lost because those potatoes became a barrier to increased sales within the channels of retail distribution. Certainly the grocer should have removed such unsalable merchandise from display, but if the shipper had done so in the first place, the retailer would not have had the problem. Thus, aggressive merchandising is a joint operation that begins with the production of the right kind of potatoes and ends with a consumer who is well enough satisfied with quality so that she will ask for "more of the kind that I bought last time" and gets them. Only when that is the regular occurrence can the potato industry assume that it has done a good job. Even then it must continue to do so indefinitely.

Up to this time reference to the potato support program has been almost entirely omitted intentionally because that is not the primary subject which I have been asked to discuss. To do so adequately, would require much more time than is available. The Steagall support programs, as a whole, need no better recommendation than the fact that almost the entire world is looking to the United States for food. This tremendous increase in production could not have been achieved if farmers had been compelled to face the entire risk of market prices alone, remembering their experience after the First World War. With the government prepared to assist in absorbing the price risk, growers could concentrate their attention on production of the food products needed for war purposes.

But we must all recognize that such a program was to meet war needs, and is not suitable for peacetime conditions. However, if the United States is to adopt a national policy of abundant food production to assure consumers an adequate supply at all times, then the country must be prepared to protect producers against the price effects of an

oversupply when it occurs, as it inevitably will.

But fundamentally when a permanent support program is developed, it must be only a supporting part of the broader program to produce efficiently and distribute the potato supply to the American people. It will fail to achieve its purpose if it dominates the industry as has been the case in certain respects during recent years, especially after the end of hostilities. Insofar as possible, the many lessons which have been learned during the support period should be utilized in the development of any future long-time program.

Growers and dealers cannot look to a long-time support program as a panacea for all their ills. Nor can they expect such a support program to guarantee them a profit, especially in the face of a declining consumption of their product. Those districts which have been consistently selling the government from 20 to 50 per cent or more of their production are either growing too many potatoes, or the wrong varieties or need to give their marketing machinery a thorough overhauling, if they are to survive during the post-war period.

I know of no better way to close this discussion than to quote certain portions of the resolutions adopted by the American Farm Bureau Federation in Chicago last month which relate to this particular subject:

"We urge continued aggressive efforts to stimulate increased consumption of agricultural commodities through research, education, and improvements in production and marketing techniques; reduction in costs of production, processing and marketing; development of new and expanded outlets for agricultural commodities in domestic and foreign markets; diversion of surpluses into by-product uses; disposal of surpluses in export markets at competitive world prices, including the use of export payments when necessary; development and use of international commodity agreements and adequate wisely-planned, economically-administered programs designed to utilize a maximum of surplus agricultural commodities.

"We believe that every reasonable effort should be made to maintain adequate demand and consumption. However, when surpluses approach unmanageable proportions, it is imperative that farmers have adequate programs to control and adjust supplies so as to prevent the wrecking of farm prices, the destruction of farm purchasing power, and the resulting unbalanced economy.

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"Due consideration should be given to providing sufficient flexibility in acreage adjustment programs to meet changing needs in production and consumption and to provide greater flexibility in adjusting individual production plans so as to facilitate efficient land use and not freeze acreage allotments in rigid historical patterns."

"The Farm Bureau has, through the years, fought for the principles and rights embodied in the existing permanent legislation. We do not intend to surrender these essential principles, yet we do recognize, in the light of past experience, the need for some changes in our long-time program. We favor a program based upon mandatory variable price supports for agricultural commodities. Such variable price supports should be applicable with or without quotas. The level of such supports should vary from 60 per cent to 90 per cent of parity, in accordance with the importance and peculiarity of the commodity and the supply and price position of the commodity. Sufficient flexibility should be provided to permit the producers of any commodity to have maximum authority to determine the level of the support price of their particular commodity and the utilization of the marketing quota features of the program.

* * * * * * * *

"In previous resolutions we have recognized the need for modernizing the parity formula to take into account changes in production efficiency and demand that have occurred among the various agricultural products since the original base period. Until such time as something that is clearly superior has been developed, we favor the retention of the present parity formula with adjustments among the various agricultural products according to the price relationships which existed between the various products on the basis of a ten-year moving average. Should efforts to make this change be unsuccessful, the Farm Bureau will continue to work for the best solution possible of the problem of evolving an effective parity as a formula expressing a fair exchange value for farm commodities. In making the transition from the present to the modernized parity formula, the parity price of a commodity should not be lowered by more than five per cent in any one year.

"If, as a result of the application of the above procedure, the parity price for any commodity is out of line with the parity prices for other agricultural commodities, the Secretary of Agriculture shall adjust the parity price for the commodity in question in such manner as to reflect a purchasing power that is in line with that of other agricultural commodities. The Secretary shall, either upon his own initiative or upon request of a substantial number of interested producers, hold open hearings in which evidence will be presented, and within sixty days following the initiation of a hearing the Secretary must announce his decision pertaining to a revised parity for the commodity in question."

CURRENT POTATO RESEARCH IN NORTH AMERICA

Report of Committee on Research[2]
Potato Association of America

E. V. HARDENBURG[1], *Cornell University, Ithaca, N. Y.*

Early in the life of this committee it was decided that to be of most value to the Association the committee should attempt to inventory and classify the various types of potato research projects now current throughout the United States and Canada. Accordingly no attempt was made to list projects already completed, published or about to be published. Rather it was felt that fairly complete information on work in progress would be mutually helpful to potato research workers in planning future projects provided and to the extent that such information is so classified as to indicate its real objective and scope.

Under date of the 22nd of October, 1947, a request for a list of current potato research projects was mailed to 46 states, 9 Canadian provinces, Alaska, Hawaii, the Dominion Department of Agriculture, and the U. S. Department of Agriculture. The response was prompt and generous. Replies were received from 35 states, 9 provinces, the Dominion Department of Agriculture, and the United States Department of Agriculture. This is a tribute to the spirit of cooperation which has been developing in recent years among research workers in these "Good Neighbor" countries.

In attempting to organize the vast number of research project titles into a useful report, the committee soon recognized the difficulties and limitations involved. Several titles lend themselves to cross indexing. However, for the sake of brevity, this has not been done. The reader is also asked to forgive whatever omissions appear obvious. Some of these can be excused on the basis of incomplete information; others are the fault of the committee. The following report is composed of such general headings as disease and insect control, breeding, seed, planting, fertilizer, varieties, irrigation, soil management, weed control, vine killers, hormone treatments, storage, cultural practices, quality, harvesting, and marketing. Under each of these general headings an attempt has been made to so sub-classify the subject-matter as to make it most useful.

[1]Chairman.
[2]Published as Paper No. 295. Department of Vegetable Crops, Cornell University, Ithaca, N. Y. Other member of committee, Professor Ora Smith of same address.

Breeding

Disease Resistance

Combining with quality—Indiana, Louisiana, Manitoba, Michigan, Minnesota, New York, Pennsylvania, Wisconsin

Early blight—Louisiana

Late blight—Louisiana, New York, Maine, Quebec, Manitoba, New Brunswick

Leaf roll—Maine

Mosaic—Louisiana, New Brunswick

Ring rot—Manitoba, Maine, Saskatchewan

Scab—Louisiana, Manitoba, New York, Quebec, New Brunswick, Saskatchewan, Wyoming, U. S. D. A. (Colorado)

Virus—New Brunswick

Early Maturity—U. S. D. A. (Colorado), Manitoba

Improved Varieties—Washington, Saskatchewan, U. S. D. A.

Inheritance of Tuber-set—Wyoming

Insect Resistance

General—Ohio

Aphis—New Brunswick

Regional Adaptation of Varieties—Louisiana, Saskatchewan

Undesignated—Iowa, Minnesota, North Carolina, North Dakota, Oregon

Cultivation

Method of Hilling—Ontario

Diseases and Control

Black Leg—Minnesota

Bottle-neck Tubers—Idaho

Dusting vs. Spraying—Tennessee, Prince Edward Island

Early Blight Resistance—U. S. D. A. (Louisiana)

Effect of Dormancy-breaking Gases on Tuber-borne Diseases—California

Fusarium Wilt—Idaho, New York, Prince Edward Island

General Control—British Columbia, Indiana, Iowa, Ontario, Quebec, Virginia

Hair Sprout—Minnesota

Jelly-end Rot—Idaho

Late Blight—Alabama, Canadian Department of Agriculture, Massachusetts, Maine, New York, North Dakota, Prince Edward Island, Wisconsin

Light Greening—Idaho

Nematode—Canadian Department of Agriculture, New York, Oregon, Prince Edward Island

Net Necrosis—Alberta, California, Maine

New Fungicides—British Columbia, Delaware, New Jersey, New York, North Dakota, Pennsylvania, Prince Edward Island, Quebec, Ohio, Rhode Island, Tennessee, South Dakota, South Carolina, U. S. D. A. (Maine), Wyoming

Purple-top Wilt—Alberta, Canadian Department of Agriculture, Maine, Minnesota, North Dakota

Rhizoctonia—Alberta, Canadian Department of Agriculture.

Ring Rot—Alberta, Canadian Department of Agriculture, Idaho, Maine, Minnesota, Montana, New York, U. S. D. A., Wisconsin, Wyoming

Sand Rust—Missouri

Scab Control

Relation of aluminum to—Indiana

On high-lime muck—Iowa

Relation of soil chemicals to—U. S. D. A. (Beltsville)

General—Alberta, Maine, Michigan

Scab Resistance—Minnesota, New York, North Dakota, South Dakota, U. S.D. A. (Colo.), Wyoming

Seed Piece Decay—Idaho, New York, Rhode Island

Seed Treatment—Manitoba, Maine, North Dakota

Southern Bacterial Wilt—North Carolina

Types of Sprayer Nozzles—Quebec

Use of Ultra Violet Light in Detecting Virus—Colorado

Verticillium Wilt—Idaho, Prince Edward Island

Virus Disease Control—California, Canadian Department of Agriculture, Idaho, Manitoba, Maine, Michigan, Minnesota, New York, North Dakota, Oregon, Washington, Wisconsin, Wyoming

Virus x Control—New York, Oregon, U. S. D. A. (Maine)

Witches Broom—British Columbia, Canadian Department of Agriculture

"Z" Disease—Michigan

FERTILIZER

Fertility Status of Fields—Rhode Island

Minor Elements

Aluminum and calcium—Rhode Island

General study—Colorado, South Dakota
Magnesium and boron—Ontario
Magnesium deficiency—Canadian Department of Agriculture, Prince Edward Island
Magnesium and potassium—New York, South Carolina
Sources of magnesium oxide—New Jersey
Sulfur deficiency—Idaho

Nutritional Requirements—Major Elements
Analysis, ratio and formula studies—Colorado, California, Missouri, Pennsylvania, Virginia

Calcium Requirements—North Carolina, Ontario, New Brunswick, Prince Edward Island
Levels of Phosphorus—New Jersey
Nitrogen and Phosphorus Ratio—Montana
Nitrogen and Potash Ratio in Tissue—Kentucky
N P and K Ratios with Tissue Analyses—Manitoba, Ontario, Quebec
Potash Levels on Muck Soil—Quebec

Placement—California, Massachusetts, New Jersey, New York, Ontario, Pennsylvania, Quebec, Virginia, Wisconsin

Rate of Application—Alberta, New York, Ontario, Pennsylvania, Prince Edward Island, Tennessee, Wisconsin

Relation of Soil O. M. to Fertilizer Response—Montana

Undesignated—Alabama, Alberta, Delaware, Iowa (muck), Ohio, Oklahoma, Rhode Island, Texas

Harvesting

Improved Equipment—Idaho, Maine, Michigan

Machinery Studies—Ontario

Mechanical Injury—Idaho

Hormone Treatment

Dusted on Cut Seed—New York, U. S. D. A. (Colo.)

Sprayed on Plant—New York, U. S. D. A. (Colo.)

Insects and Control

Aphids—California, Maine, New Brunswick, New York, Ontario, Wisconsin

Colorado Beetle—Alberta, Prince Edward Island

Flea Beetles—British Columbia, New York, Prince Edward Island, Wisconsin, Wyoming

General—British Columbia, Indiana, Minnesota, New York, North Dakota, Ohio, Ontario, Quebec, U. S. D. A. (Colo.), Virginia

Hoppers—New York, Ontario, Wisconsin

New Insecticides—New Jersey, New York, Pennsylvania, Rhode Island, Quebec, Manitoba, Tennessee

Psyllids—Wyoming

Tuber Flea Beetle—British Columbia

White Grub—Ontario

Wireworms—Connecticut, New Jersey, New York, Ontario

Irrigation

Cost of Operation—Alabama, New York

Effect on Yield—New Jersey, New York, South Carolina

Effect on Use of Fertilizer—South Carolina

Furrow vs. Overhead—Montana

Relation to Seed Spacing—New Jersey

Relation to Use of Surface Mulch—Alabama

Undesignated—Alabama, California, Maine, Ohio, Oklahoma, Virginia

Use of Soil Tensiometer—U. S. D.A. (Colo.)

Marketing

Consumer Packaging—California, Idaho, Maine, New York

Consumer Preference Studies—Colorado, Idaho, North Dakota, Wisconsin

Dehydration Studies—Iowa, Kansas, Maine, North Dakota, New York

Market Quality—Minnesota

Potato Flour Manufacture—North Dakota

Potato Granules Manufacture—Kansas

Shipping Studies—California, Canadian Department of Agriculture, Maine, U. S. D. A. (Beltsville)

Sizing Studies—Idaho

Undesignated—Iowa, Michigan, Minnesota, North Carolina, North Dakota

Planting

Depth—California

Seed Spacing—Tennessee

Time—California, Pennsylvania

Quality

Discoloration During Dehydration—Indiana

Effect of Fertilizer on Quality—Colorado, New York

Effect on Growth Conditions—Indiana (muck), Michigan, Minnesota, New York, Pennsylvania

Vitamin C Studies—Louisiana, Minnesota, New York, Wisconsin

Seed

Certified Seed Production Studies—Canadian Department of Agriculture, Minnesota

Effect of Chemical Treatment on Size and Set of Tubers—Maine, New York, U. S. D. A. (Colo.)

Effect of Early Harvest on Virus Control—U. S. D. A. (Maine)

Effect of Frost on Seed Value—Canadian Department of Agriculture

Effect of Nitrogen on Seed Value—Montana

Effect of Sprout Inhibitors on Seed Value—New York

Factors Affecting Tuber-set and Date of Maturity—U. S. D. A. (Maine)

Greening Seed—New York

Hormone Treatment of Cut-Seed—New York

Maintaining Stocks Free from X Virus—U. S. D. A. (Maine)

Regional Adaptation—Virginia

Treatment and Packaging of Potato Eyes—Alberta

Treatments to Protect Cut Sets—Alberta, California, New York

Virus Detection in Seed Tubers—U. S. D. A. (Colo.)

Soil Management

Depth of Plowing—Prince Edward Island

Erosion Control Studies—Maine, Prince Edward Island

Rotation Studies—Iowa, New Brunswick, Nova Scotia, Ontario, Pennsylvania, Prince Edward Island, Quebec, Virginia

Soil Acidity Studies—Pennsylvania

Soil Improvement with Green Manures—Alabama, Maine, Ohio, Ontario

Soil Oxygen Supply—Ohio

Soil Type Studies—Iowa, Michigan, Ontario, Virginia

Storage

Effect of Containers on Storage Quality—New York, Ontario

Effect of Fertilizer on Storage Quality—Colorado

General Storage Studies—California, Maine, Michigan, U. S. D. A. (Beltsville)

Low Temperature Effects—Canadian Department of Agriculture, Ontario, Prince Edward Island

Pathological Changes in Storage—Minnesota

Sprout Inhibitors—California, Canadian Department of Agriculture, New Jersey, New York, Ontario

Varieties

Blight Resistance—Alberta, British Columbia, Manitoba, New Brunswick, Nova Scotia, Ontario, Prince Edward Island, Quebec, Saskatchewan

Classification—U. S. D. A. (Maine)

Disease Resistance—Iowa, Ontario, South Carolina, Wyoming

Insect Resistance—Ohio, Ontario

Mosaid Resistance—New Brunswick, Nova Scotia, Ontario, Quebec

Psyllid Resistance—Wyoming

Quality Studies—Minnesota, New York, South Carolina

Ring Rot Resistance—Wyoming

Scab Resistance—Alberta, British Columbia, Manitoba, Massachusetts, New Brunswick, Nova Scotia, Ontario, Prince Edward Island, Quebec

Storage Quality—Louisiana

Undesignated—Oklahoma

Virus Resistance—Alberta, British Columbia, Manitoba, New Brunswick, Nova Scotia, Ontario, Prince Edward Island, Quebec, Saskatchewan

Yield—Alberta, British Columbia, California, Delaware, Idaho, Iowa, Manitoba, Maryland, Maine, Mississippi, New Brunswick, New Jersey, Nova Scotia, New York, Ontario, Rhode Island, Saskatchewan, South Carolina, Tennessee, Texas, U. S. D. A. (Colo.), Virginia, Wyoming

Vine Killers

Effectiveness of Chemicals and Flame—British Columbia, California, Colorado, Maine, New York, North Dakota, Ontario, Prince Edward Island, South Dakota, U. S. D. A. (Colo.)

Weed Killers

Effectiveness of Chemicals and Flame—Michigan, New York, Ontario, Pennsylvania, Rhode Island

Tolerance to 2,4-D—Manitoba

In summarizing this report, some reference should be made as to which of the 17 general potato projects are currently being most extensively studied. The number of phases of each project and the corresponding number of states and provinces involved with them are shown in the following table:

Project	Number of Phases Being Investigated	Number of States and Provinces Involved
Breeding	14	21
Cultivation	1	1
Disease control	30	38
Fertilizer	19	32
Harvesting	3	4
Hormone treatment	2	2
Insect control	10	23
Irrigation	8	11
Marketing	9	13
Planting	3	3
Quality	4	9
Seed	14	10
Soil management	7	12
Storage	6	11
Variety tests	13	29
Vine killing	1	10
Weed killing	2	6

Disease and insect investigations, the breeding and testing of new varieties and fertilizer studies, although not new projects, still command far more time of our research workers than any others. Relatively little study is now being given to such phases as cultivation, planting, seed and harvest. Irrigation, storage and marketing are phases of the industry which seem to have pretty well maintained their average quota through recent years. Among the newer phases of potato research, which are currently receiving an increased amount of study, are hormone and other chemical treatment of seed and plant to increase tuber-set and yield, and to control sprouting in storage; also the use of chemicals and flame not only to control weeds but also to kill potato vines.

SECTIONAL NOTES

Alabama

Alabama potato growers are very much confused and disgusted. After battling worse than normal odds with the weather, cost, and other factors, which finally resulted in a better than normal crop for size and quality, the Railroad strike has stopped shipment of potatoes just as we are getting started. Our conditions being what they are for the development of soil diseases makes a very serious condition. The strike is not to take place until next Tuesday, the 11th of May, but as of midnight on the 6th, shipments will be stopped so that delivery can be assured by the railroads.

Two years ago our growers remember what the strike did to some potatoes that were caught in transit as well as the ones that had to be left in the field. It is therefore our hope that something reasonable can be done or else there will be much loss to our growers. Trucks give some hopes but not enough.

The delay in harvest operations was caused by the fact that our crop matured somewhat later than last season. Refertilization and slower development of late blight, contributed to this later maturity. Our dealers agreed to let the crop mature for a longer period to prevent loss usually suffered in our early shipments.

The support program is very confusing here at this time. Our growers in general wanted assurance of support; our dealers could not see their way clear to sign up because of the guarantee demanded for delivery in grade. It seems that our dealers will handle the crop above support if possible, or leave it up to the support people to come through with something that they can work under. It is understood that they will give the B size back to the growers as soon as the price for them is below support.

Our deal has been one of confusion the entire year. We still have hopes that things will work out better than it now seems possible. We have a good crop of potatoes with fair size and quality.—Frank E. Garrett.

California

Kern County potato harvest is well underway at the present time. A total of 1,181 car loads has been shipped, primarily from the Edison district of Kern County as of the 28th of April. The yield from the fields in the earliest districts is not so high as in previous years because of the early frosts and continued cool weather during the spring months.

A number of the packing sheds are now waxing the new potatoes. It is said that the market response to this process is enthusiastic.

In general the potatoes are of high quality and a minimum amount of scab or other diseased conditions appear. During the first week of May it is expected that several more areas will begin harvesting operations, and it is expected that by the end of May, harvest will be in full swing in all areas.—DAVID N. WRIGHT.

COLORADO

The San Luis Valley, an area on the upper Rio Grande river comprising five counties in the southern part of Colorado and lying between the Sangra de Cristo range and the continental divide, has started a new potato improvement program. This area like most other potato areas has had its troubles from potato diseases both in the field, in storage and in shipping. Also like other potato areas, the research answers to combat these problems have not come along fast enough under available facilities. Consequently, the San Luis Valley, with the aid of the San Luis Valley Potato Improvement Association and other organizations, took steps, last year, to increase these facilities by making use of the Marketing Agreement Act and the provision providing for the collection of fees for improvement purposes. Accordingly, hearings and referenda were held and the growers voted into effect a collection of one cent per hundred-weight on all potatoes sold in the San Luis Valley or shipped from the Valley. The Marketing Agreement Act is administered for the state of Colorado by the State Department of Agriculture and is administered locally by a Board of Control which consists of members elected from the area concerned.

The program got under way on the first of March, 1948. The San Luis Valley Potato Improvement Association made available a farm which they had leased for a number of years for research and improvement work and subsequently signed an agreement with the Board of Control to provide funds for research and improvement. Several new research and demonstration programs were under way. Considerable time and effort are being given to the study and control of Western Leak, a field and storage rot of potatoes. More effort is being given to the study of seed piece decay particularly on cut seed; also a study of the effect of hormones on potato yield and quality is being started; and the potato fertilizer studies are being enlarged to a certain extent.

In addition, more demonstration work is being done in regard to fertilizers and diseases and insect control on farms throughout the Valley.

A Governing Committee of five men, three from the Improvement

Association and one each from the Colorado Extension Service and the Agricultural Experiment Station was established for the new program in the Valley. This committee supervises the expenditures of funds; recommends and approves new research and improvement work and manages the experimental and demonstration farm maintained in the Valley.—CECIL W. FRUTCHEY.

INDIANA

During the greater part of April and up to the present, we have had some wonderful weather for potato planting. Many of our growers have their acreage in, with the bulk of the planting being Irish Cobbler and Katahdin and the Sequoia seemingly is replacing the Chippewa as one of our good varieties. Many of our home gardeners and the small potato patch men, those having one acre or so, are very keen for Sequoia seed but evidently we are having a severe shortage of this variety for almost daily I get letters from people asking where they may obtain this seed. Our certified seed growers could possibly take advantage of this for, undoubtedly, many thousands of bushels could be sold, if properly marketed.

The acreage in Indiana will be about the same as it has been in years past. We will still have a shortage varying between five and six million bushels of potatoes for potato stock when fall comes and all the surrounding states to the east, west, and south of us are in the same predicament, so we consumers in Indiana spend and send to other potato-growing areas somewhere in the neighborhood of ten to twelve million dollars every year. We need more potato-minded people in this territory and yet we want to be very gracious to the growers in the northern areas who are limited to certain crops and cannot grow the wide varieties that can be grown in Indiana.—W. B. WARD.

MISSOURI

Last year, Missouri commercial potato growers planted 2,800 acres. The flood destroyed 800 acres and left 2,000 acres for harvest. This year they planted only 2,500 acres. The majority of the acreage is Irish Cobbler. However, Red Warba is growing in popularity, and it ranks fairly high in our acreage.

Some of the northern-grown certified seed potatoes shipped into this area this spring showed an internal brown ring. This browning of the vascular tissue had resulted from the destruction of the potato top by use of a burner before harvest. However, the seed was perfectly good in all other respects, and a very satisfactory stand was obtained.—ALLEN PURDY.

New Jersey

The potato crop was practically all planted by the 1st of May. Most of the plants have now emerged and some fields are being sprayed. Flea beetles are quite abundant in many locations and DDT is being used to control them.

Considerable interest has been shown in airplane dusting and many growers have contracted with operators of airplane dusters to dust their fields throughout the season.

No blight is present in our fields as yet but growers are, in general, ready to control any outbreak. The heavy rains of the past week have prevented some growers from spraying or cultivating so that flea beetles and weeds are causing these growers a great deal of concern. The rains have also caused some growers, whose plantings are on sandy loams, to consider side-dressing their potatoes with extra fertilizer. Nitrogen and potash, the elements most needed, are not very plentiful, but it is believed that enough is available to take care of any normal demand.

The Annual Summer Meeting of the New Jersey State Potato Association will be held on the 15th of June on the farm of Mr. Spencer Perrine at Cranbury. Prominent speakers are being secured to discuss current potato problems on production and marketing. A large exhibit of farm machinery will be displayed and demonstrations of aircraft dusting *vs.* ground dusting will be featured. Investigators at the Experiment Station have a fertilizer broadcast experiment, a variety test including 40 potato varieties or strains of varieties, and a weed control experiment located on this farm, and all growers desiring to inspect them may do so.

This announcement is your invitation to attend. Forsgate Airpark, located ½ mile from the farm, has excellent facilities for handling planes of those interested in flying to the meeting. Arrangements may be made for free transportation to and from the Airpark by contacting the undersigned in care of New Jersey State Potato Association, New Brunswick, New Jersey.—John C. Campbell.

New York

Preliminary reports indicate that the acreage for New York State will be about normal. Long Island has already planted close to their allotment and up-state growers are probably going to be slightly under their allotment.

Table stock is pretty well cleaned up on available stocks and there will be no surplus; the same situation existing in the seed market. Prices range 30 cents above support at the present date.


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The Annual Summer meeting of the Empire State Potato Club will be held at the farms of J. W. Hopkins & Son and Irving N. Hopkins of Pittsford, New York, on Thursday, the 12th of August. This section is an intensive crop area in contrast to last year's location. Farm machinery manufacturers have already promised the Club their support in making this one of the best Field Days we have ever had.

The Winter meeting of the Empire State Potato Club and the New York State Vegetable Growers' Association will be held in Utica on the 5th, 6th and 7th of January. Committees have been appointed, who are active in arranging all details necessary for a successful convention.

Much interest is being shown in new machinery. Mechanical cutters have been very prevalent during the spring season. Also much interest is being shown in devices for handling potatoes both in bulk and packages.

One of the interesting items for the Summer Field Day will be the Roto-Beater which chops up the vines on short notice.—H. J. EVANS.

OREGON

An extremely wet spring has delayed farm planting. In general, most of the potato land is still too wet to plant. The average seeding will be late. However, we expect some increase in the certified seed acreage; which comprises Russets and White Rose. Increased eye-indexing studies will be undertaken, the eyes having been planted in south-central California early in January. This is in the nature of a demonstration and a number of growers are particularly interested in it. Eye-indexing may grow rapidly if this year's work is satisfactory.

Apparently, farmers are planting very close to their goals which will make a district increase in acreage of approximately 25 or 30 per cent, more than in 1947.—C. A. HENDERSON.

SOUTH CAROLINA

The rains which plagued South Carolina potato growers ceased about a month ago. Because of these excessive rains the crop varies from good stands to no stand at all, and from good growth to very poor growth. The rain that has fallen the past two days will be almost sufficient to finish the crop.

Late blight has been present for nearly a month. Some spores were disseminated during the rain that fell on the 15th of April, and caused some infection, but conditions have been unfavorable for the disease since that period. Most of the growers are using Copper DDT dust, although a few are using Dithane as a spray.

The crop should begin moving to market about the 24th of May and

present prospects indicate one-half a normal crop. A large portion of the crop will be washed and shipped under refrigeration.—W. C. BARNES.

SOUTH DAKOTA

Potato planting is now underway in South Dakota at this writing, the 4th of May. The ground is in excellent condition with plenty of moisture. A number of carloads of foundation seed from North Dakota, Minnesota, Michigan and Wisconsin have been received by growers.

A marketing agreement has been approved for South Dakota and a meeting to select committee men will be held the first part of June. R. E. Keller from the Fruit and Vegetable Branch from Chicago will be in South Dakota for the meeting.

Tentative plans have been made to cooperate on the field inspection work with South Dakota State College this year. At present we are planning to secure a highly trained man to do field inspection work in the summer for the potato growers and research work for the College during the winter months.

Indications are that the acreage entered for certification will be as large or larger than the 6,350 acres entered in 1947. The 1947 crop is all cleaned up although it was necessary for the P. and M. A. to purchase 165 cars to support the price. Most of these were Cobblers.

There will be a fair acreage planted to LaSoda, the cross between Triumphs and Katahdin, which was made by Dr. Miller of Louisiana State. This is an early to medium-early variety, has a very bright pinkish red skin and has been a very good yielder.—JOHN NOONAN.

VIRGINIA

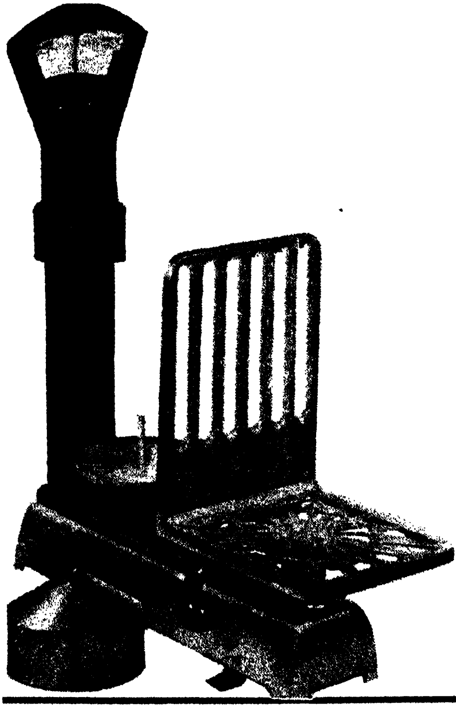
Weather conditions in the entire early commercial potato growing area of Virginia have been excellent so far. As we reported to you last month, we had no trouble with seed pieces rotting in the ground like North and South Carolina did, and as a result, we have almost a perfect stand. Rainfall has been abundant and fairly well distributed. The weather has been a little cooler than normal, under which young growing potatoes seem to thrive. Our shippers are estimating that if the favorable weather continues, Virginia will have about 15 per cent more potatoes this year than they had last year with approximately the same acreage. Of course, dry weather between now and the 15th of June could reduce the yield, but there is every likelihood that we will get two or three more nice rains between now and then.

The potato industry in other states will be interested in hearing about the results of the grower referendum in North Carolina and Virginia on our Southeastern States Potato Marketing Agreement. It

is our understanding that these results will be announced from Washington in a day or so if they have not been already. We hear that 86 per cent of the growers in North Carolina favored the marketing agreement, and about 71 per cent of the growers in Virginia favored it. At the present time dealer signup under the agreement is being pushed by County P. and M. A. offices. Many of the larger volume potato dealers in the two-state area have already signed the agreement, and it is anticipated that more than 50 per cent of the dealers on a volume basis will sign it. As soon as the dealer sign-up drive is completed, and the results of both grower referendum and dealer sign-up have been presented to the Secretary of Agriculture, he will undoubtedly issue an order declaring the marketing agreement in effect for this year. Meetings of growers and handlers have been held in each of the six Districts of North Carolina and Virginia under the agreement for the purpose of electing dealer and grower nominees from which the Secretary of Agriculture will select members to the Administrative Committee which will operate the agreement. These lists of growers and handlers will be available to the Secretary for selecting committee members as soon as he approves the marketing agreement.

In the eastern potato section of Virginia our growers will have potato acreage quotas and a support price program on their fall crop for the first time this year. All of the principal potato-producing counties in the area have issued acreage quotas to growers for the fall crop. Although the acreage planted here for the fall crop is small, considerable interest has been indicated in this crop. Many growers feel they can now control late blight which is nearly always a factor here in our late crop, and perhaps more of a fall crop will be planted here in future years. In Virginia this crop is usually plantel in July and harvested in late October or early November. Some growers report that they can get heavier yields than they can on their spring crop. Several of the larger growers have portable irrigation systems which they use on their fall potatoes.

The large new packing shed which will be operated this year by Mr. Guy Capps at Euclid, Virginia, near Kempsville, is about ready. There will be 6 washers and driers in this shed instead of 5 as previously reported. Mr. Capps will operate another washer and drier in Norfolk. The Euclid shed will wash and dry between 135 and 150 carloads of potatoes per day, operating on a 20-hour day. The Norfolk section of Virginia will probably be able to sell a large proportion of their potatoes on the commercial market as a result of this large washing and drying operation here as compared with the Eastern Shore of Virginia, which will have no washers and driers this year.



The Department of Agriculture and the State and P. and M. A. office have held meetings with dealers and County P. and M. A. Committees in North Carolina and Virginia for the purpose of explaining this year's dealer contract under the price support program and for getting recommendations from the dealers on the charges which dealers are permitted to deduct from their returns to growers. The North Carolina dealers recommended the same charges las last year which were: 10 cents for hauling from field to grader; 13 cents for grading; 26 cents for new bags; 6 1/3 cents for loading on cars; 1 2/3 cents for inspection; and 6 cents for selling; or a total of 63 cents. This will probably be approved by Washington. Norfolk section of Virginia dealers have recommended 12 cents for hauling; 18 cents for grading; 23 cents for new bags (12 cents in case bags are used); 2½ cents for loading in cars; 1½ cents for inspection; and 6 cents for selling; making a total of 63 cents, the same as North Carolina. Eastern Shore of Virginia dealers are recommending a slightly higher charge for grading, sacks, and selling, but it remains to be seen whether the Department of Agriculture in Washington will approve the higher charges for the Eastern Shore than those recommended by the Norfolk section dealers. The Department may arrive at a compromise which allows Eastern Shore dealers a slight increase over Norfolk section and North Carolina dealers.—EDWIN W. CAKE.

WEST VIRGINIA

Most of the commercial potato plantings in West Virginia were planted between the 1st of April and the 1st of May—with Katahdins being the chief varieties planted.

The recent flood of the Ohio River did considerable damage to the Cobbler plantings in Wood and Mason Counties. Some of the growers are planning to replant.

The growers who are members of the West Virginia Potato Growers Association have ordered 190,000 peck bags. All the members of this association are using a similar brand. For the first time, all the potatoes packaged in bags adopted by the association will be inspected. This inspection will be done by a Federal-State inspector who will be employed by the State Department of Agriculture in cooperation with the Federal Inspection Service.—CLAUDE R. KEMPER.

ONTARIO

Potato market continues firm, with major supplies on farms about cleaned up, except for a number of small individual lots which may

become available after planting has been completed. Planting of the early crop was finished about normal time, and conditions have been favorable for growth. On the 7th of May, some of the intermediate and late crops had already been planted. In other cases, preparations are being made, and it looks like as if the entire crop may be planted earlier than normal. It is difficult to predict acreages but many growers are talking about reduction, considering circumstances with respect to seed and labor. There has been a very definite shortage of Foundation seed of the Chippewa and Sebago varieties. Katahdin and Irish Cobbler have been in fair supply, and an increased number of growers will likely plant the Green Mountain variety this year.

Much interest is evident in the program of research being undertaken in connection with the ever-increasing menace of scab disease. Growers have already signified appreciation of Departmental efforts by contributing rather generously to supplement the $10,000.00 allocated from this years' appropriation for an active concentrated, co-operative study of the situation.

Action is being taken on resolutions passed at the Annual Meeting, Ontario Crop Improvement Association, and favorable response is being received in a number of cases.

A scheme to regulate marketing under the Farm Products Control Act for early potatoes in South Western Ontario is under way.—R. E. Goodwin.

Canada

Canada has exported more certified seed potatoes up to the 31st of March than had ever been exported in a full crop year previously.

There were 3,489 bushels exported from the 1944 crop. This was a previous record. Up to March 31, 1948, there were 4,056,827 bushels shipped from the 1947 crop.

Shipments were made to 19 countries, but the United States and Argentina took more than 80 per cent of the total. The bulk of the shipments consisted of the Katahdin, Green Mountain, Irish Cobbler, Bliss Triumph and Sebago varieties. Prince Edward Island and New Brunswick supplied more than 90 per cent of the seed, but all other provinces with the exception of Quebec and Saskatchewan supplied substantial quantities. British Columbia shipped more than 51,000 bushels of White Rose to Argentina.—J. W. Scannell.

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YIELD AND GRADES OF BLIGHT RESISTANT POTATOES GROWN* IN TWENTY DIFFERENT LOCATIONS IN NEW YORK STATE IN 1947

ARTHUR J. PRATT

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Twenty varieties of potatoes were planted in 20 different locations, including Long Island and all of the important potato growing sections of upstate New York. Older 4-H Club boys were chosen as cooperators. The layout was a randomized Latin Square with each replication at a different location. Green Mountain, Katahdin and Rural varieties were used as standards. The remaining 17 varieties were blight-resistants developed by Dr. Donald Reddick of Cornell. Eight of the latter were named varieties and 9 were numbered seedlings.

All plantings were made during the latter half of the potato planting season in each area. On Long Island this period ranged from the 15th of April to the 20th and in upstate New York from the 10th of June to the 20th. It was planned to spray all plots with DDT only, so that blight resistance could be checked as well as the yield and other factors. However because of the inconvenience of not using copper in small section of the regular field, 4 plots did receive copper sprays. Four others received no spray whatever and in those plots, the varieties most susceptible to leafhopper injury, such as Chenango and Snow-

*Paper 300, Department of Vegetable Crops, Cornell University, Ithaca, N. Y.

drift, were killed early and yielded less than where protected against this injury.

All plots were harvested after frost had killed the plants, except on Long Island where they were all mature by digging time—the 23rd of September. Dry weather for eight weeks before frost in the upstate area caused the earliest and least hardy varieties to "mature" before frost.

At harvest, the number and weight of tubers were recorded. The tubers were sized into those over 2 inches and those under 2 inches in diameter. Those over 2 inches were divided into those that would pass the U. S. No. 1 grade standard and those that would not. Those that failed to make the No. 1 grade were divided into the following lots: (1) scabby; (2) misshapen and second growth; (3) sunburn, and (4) tuber rot.

Tubers injured only by insects or mechanical means were included with the No. 1's as these defects were considered unrelated to the genetic makeup of the variety. An analysis of variance of the data showed that all results were significant at the 1 per cent level.

The average yield of the 20 varieties on the 20 plots was 229 bushels of U. S. No. 1's and 337 bushels total per acre. On the total yield basis. 15 of the blight resistant varieties outyielded all three of the standard or blight-susceptible varieties. Fourteen of the 17 new blight-resistant varieties gave higher average yields of No. 1's than any of the 3 standards.

Of the standard varieties Katahdin had the highest yield of U. S. No. 1's over 2 inches—180 bushels per acre. This yield was exceeded by 14 of the 17 blight-resistant varieties and was exceeded by a difference significant at the 1 per cent level, by Essex, DUA-11, Ashworth, Placid. DZE-10, DUA-2, Virgil and DVA-10; and at the 5 per cent level by Chenango.

Green Mountain, the highest yielding of the standard varieties when compared on a total yield basis, was exceeded in total yield by 15 of the 17 blight-resistant varieties. This difference was significant at the 5 per cent level in the case of 8 varieties.

When compared on a basis of the weight of scabby potatoes, (table 1) Ashworth and Essex showed significantly more scab at the 1 per cent level than did CRF-3, DXM-3, EVI-2, FBY-1, Rural and Snowdrift, and also significantly more at the 5 per cent level than Chenango, DUA-2, DVA-10, Empire, Fillmore and Katahdin. When scabby tubers are compared on a count basis the picture is much the same except that only Essex has significantly more scab at the 1 per cent level than the least scabby varieties. As will be seen in table 2, this

TABLE I.—*Weighted yield per acre.*

Variety	Maturity	No. Locations Where Yield Was Better Than Green Mountain, Katahdin and Rural	Weighed Yield per Acre: Over 2": U. S. No. 1's Bu.	Over 2": U. S. No. 1's Rank	Over 2": Scabby Bu.	Under 2" Bu.	Total Bu.	Total Rank
Ashworth	Early	17	320	3	41	37	423	3
Chenango	Early	13	235	9	16	80	346	8
CRF_3	Late	12	223	11	14	40	297	14
DUA_3	Midseason	13	266	6	18	80	392	7
DUA_{11}	Midseason	18	329	2	23	58	458	2
DVA_{10}	Early	17	251	8	18	36	320	11
DXM_3	Midseason	8	137	20	7	75	242	19
DZE_{16}	Midseason	16	286	5	35	49	397	6
Empire	Late	12	207	12	17	35	281	15
Essex	Early	17	345	1	41	69	480	1
EVL_3	Late	9	161	18	13	94	306	13
FBY_1	Late	9	187	14	12	98	312	12
FIG_3	Midseason	8	178	17	25	98	321	10
Fillmore	Late	9	194	13	16	45	271	17
Green Mt.	Midseason	—	177	16	21	61	277	16
Katahdin	Midseason	—	180	15	16	49	269	18
Placid	Midseason	16	289	4	22	61	415	4
Rural	Late	—	138	19	7	63	213	20
Snowdrift	Early	11	218	10	12	76	322	9
Virgil	Midseason	15	266	7	20	70	402	5
Average			229		19.6	63.7	337	
LSD 1 per cent			62		29	27	85	
LSD 5 per cent			47		22	20	65	

TABLE 2.—*Number of potatoes per hill.*

Variety	Over 2"					Under 2"	Total	
	U. S. No. 1's		Scabby		Blight Rot			
			All Plots	*No. 6 Omitted				
	No.	Rank	No.	No.	No.	No.	No.	Rank
Ashworth	3.55	8	.46	.24	.066	1.67	6.04	13
Chenango	3.70	6	.26	.08	.068	3.72	8.00	5
CRF-3	2.97	13	.20	.07	.116	1.76	5.21	19
DUA-2	3.72	5	.26	.05	.046	3.82	8.21	3
DUA-11	4.17	2	.26	.02	.140	2.54	7.50	8
DVA-10	3.04	12	.22	.10	.104	1.71	5.32	17
DXM-3	2.45	17	.11	.04	.054	3.37	6.29	12
DZE-10	3.66	7	.42	.24	.034	2.25	6.72	11
Empire	2.62	15	.18	.01	.196	1.53	4.60	20
Essex	4.68	1	.54	.38	.030	3.48	9.03	1
EVI-2	2.34	19	.17	.07	.070	3.80	6.77	10
FBY-1	3.17	10	.17	.01	.106	4.55	8.02	4
PIG-3	3.12	11	.46	.24	.262	4.95	8.92	2
Fillmore	2.70	14	.22	.04	.040	2.12	5.24	18
Green Mt.	2.43	18	.32	.11	.226	2.84	5.89	14
Katahdin	2.59	16	.26	.08	.152	2.10	5.34	15½
Placid	3.76	3	.28	.05	.122	2.51	7.17	9
Rural	2.20	20	.12	.01	.060	2.96	5.34	15½
Snowdrift	3.52	9	.23	.10	.092	3.47	7.57	7
Virgil	3.74	4	.28	.08	.048	3.31	7.93	6
Average	3.21		.271	.1056	.1006	2.92	6.76	
LSD 1 per cent	1.16		.40	.23	.16	1.18	1.52	
LSD 5 per cent	.88		.30	.14	.12	.89	1.16	

*The figures are shown both with and without location No. 6, as in that location 77 per cent of all tubers over 2" were too scabby to pass the U. S. No. 1 grade. With plot No. 6 included, varietal differences were barely significant at the 1 per cent level, but without it they become much more significant.

difference became more significant when the figures were recalculated with location No. 6 omitted. (See footnote to table 2.) It should be understood that counts of scabby tubers were only an incidental part of the record taking and that no special effort was made to include scab-resistant varieties. Only one of the 20 locations (table 3) showed an amount of scab significantly above the average. There the 20 varieties averaged 258 bu. per acre with tubers too scabby to meet the U. S. No. 1 grade.

The number and weight of sunburned tubers were significantly above average in the case of Placid and Virgil. However, some locations were practically free from sunburn on all varieties, so it can probably be assumed that cultural practices could be modified to keep this defect low on these varieties. Katahdin, Essex and DUA—2 also had more than an average number and weight of sunburned tubers, though not by a significant amount.

One measure of the advantages gained by planting blight-resistant varieties is the increase in the average yield of all resistant varieties compared with that of all susceptible varieties. When based on the average yield at the 20 locations, this increase was 75 bushels per acre of No. 1 potatoes—240 bushels compared with 165 bushels and the increase amounted to 99 bushels per acre total yield—352 bushels as compared with 253 bushels. However, in the 8 locations where blight was not serious, the yield of the susceptibles was 286 bushels of No. 1's and 352 total and of the resistant varieties the yields were 269 bushels of No. 1's and 365 bushels total yield, an insignificant difference. Whereas, in the 12 locations where blight was serious the yield of the susceptibles was only 87 bushels of No. 1's and 187 bushels total and of the resistant varieties 222 bushels of No. 1's and 343 bushels total or a difference of 135 bushels No. 1's and 156 total, an extremely important difference.

Blight rot was counted only on tubers over 2 inches in diameter. This proved to be a poor measure of blight resistance for where blight was serious early in the season, very few tubers on the susceptible varieties ever reached the 2-inch size. In 6 locations blight killed both Rurals and Green Mountains so early that the yield of No. 1 potatoes did not exceed 50 bushels per acre.

No blight resistance has been claimed for the tubers of these resistant varieties. However, the tops of the resistant varieties remained alive from 4 to 6 weeks after Katahdins, whereas the Rurals and Green Mountains had been killed by late blight.

The potential yielding power of any variety, when grown under

TABLE 3.—*Yield by locations.*

Location	Weighted Yield per Acre						Potatoes per Hill				
	Over 2"				Under 2"	Total	Over 2"			Under 2"	Total
	US No. 1's	Scabby	Sunburn	Other Defects			US No. 1's	Scabby	Blight Rot		
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	No.	No.	No.	No.	No.
1 Aqueboque	414	0	5	9	68	496	5.18	.00	0	2.71	8.06
2 Laurel	388	2	13	8	101	512	5.20	.02	.004	4.44	9.97
3 Maples	290	10	31	20	61	412	3.68	.22	.024	2.60	7.08
4 Ithaca	120	7	33	24	51	235	1.78	.20	.172	2.54	5.22
5 Cincinnatus	171	1	1	18	53	244	2.50	.02	.426	2.31	5.28
6 Heuvelton	62	258	7	22	52	381	0.94	3.53	.016	2.12	6.68
7 Candor	209	2	1	1	51	264	2.89	.02	.326	2.56	5.50
8 Bath	330	3	17	41	56	447	4.12	.03	0	2.11	7.03
9 Clinton	191	3	5	6	47	252	2.96	.04	0	1.89	5.03
10 Argyle	215	3	4	1	54	277	3.42	.06	0	2.77	6.36
11 Mt. Vision	256	1	18	8	55	338	3.49	.12	0	2.31	6.24
12 Broadalbin	149	4	0	0	86	240	2.74	.08	0	4.14	6.98
13 Lounsbury	190	6	10	4	68	278	2.97	.10	0	3.60	6.90
14 Little Valley	213	28	7	57	62	367	2.78	.39	.798	2.64	6.74
15 Middletown	148	20	12	18	83	281	2.22	.30	.050	4.02	6.98
16 Marathon	189	28	4	4	71	296	2.76	.33	0	3.65	6.90
17 Richford	219	1	5	5	60	290	3.04	.01	.100	2.64	5.86
18 Williamson	303	4	1	0	47	355	4.67	.06	0	1.94	6.70
19 Ashland	231	4	24	7	105	371	3.34	.05	.070	5.39	9.24
20 Whitesville	301	5	40	13	47	406	3.66	.07	.026	2.04	6.51
Average	229	19.6	11.8	13	63.7	337	3.21	.271	.1006	2.92	6.76
LSD 1 per cent	62	29	17	—	27	85	1.16	.40	.16	1.18	1.52
LSD 5 per cent	47	22	13	—	20	65	0.88	.30	.12	.89	1.16

ideal conditions might be expected to be somewhat in proportion to the total number of tubers per plant. The named varieties excelling in this feature in the order of the total number of tubers per plant were Essex, Chenango, Virgil, Snowdrift and Placid. These were all significantly higher at (1 per cent level) than were Katahdins.

When appearance of the tubers was considered, 3 varieties, Chenango, Empire and Snowdrift, were as good if not better than Katahdin at all locations. All 3 of them yielded better than Katahdin as shown in table 4. Those that were rated as rough and unattractive in 20 per

TABLE 4.—*Number of locations where the general appearance of the tubers was rated as too rough to satisfy the general market demand.*

Variety	No. Locations	Variety	No. Locations
Ashworth	2	EVI—2	6
Chenango	0	FBY—1	2
CRF—3	3	FIG—3	1
DUA—2	3	Fillmore	5
DUA—11	5	Green Mountain	2
DVA—10	3	Katahdin	0
DXM—3	1	Placid	6
DZE—10	4	Rural	1
Empire	0	Snowdrift	0
Essex	4	Virgil	8

cent or more of the locations were Virgil, Placid, EVI-2, Fillmore, DUA-11, Essex and DZE-10. The best yielding variety was Essex, but besides being the most susceptible to scab, its appearance was rated rough and unattractive at 4 of the 20 locations.

This test covered only 1 planting date (late) in one year, 1947, but since it covered 20 locations the results justify consideration. It may be concluded that under conditions where blight control is not likely to be good, it would be safer to plant almost any of the blight-resistant varieties rather than the standard blight-susceptible varieties.

A PRELIMINARY STUDY ON THE USE OF RAPID CHEMICAL TESTS AS AIDS IN DIAGNOSING NUTRIENT DEFICIENCIES IN THE IRISH POTATO[1]

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The problem of determining the fertilizer requirements of a growing crop is one which has long concerned workers in plant nutrition. Use has been made of soil and plant analysis, pot tests, and field tests. The advantages and disadvantages of each of these methods have been discussed elsewhere (19) and need not be repeated here. It is apparent, however, that the concentration of a nutrient element extracted from actively growing tissues of plants should be an accurate indication of the effective concentration of that element in the soil. A number of investigators have devised rapid chemical tests for determining the concentrations of nutrients in plant tissues. Emmert (4, 5, 6, 7) has developed such tests which he has used (8) to determine the fertilizer requirements of tomatoes grown in Kentucky. Carolus (2, 3) has used Emmert's tests for nitrogen and phosphorus and an adaptation of Morgan's (15) soil testing methods for Mg O (magnesium oxide), K_2O (potash), and CaO (caldium oxide), on vegetable crops in Virginia. Thornton (20) and Thornton, *et al* (21) have developed similar tests which have been shown by Scarseth (18) to be valuable in diagnosing fertilizer needs. Hester (9) and Wolf (22) have used tissue tests as aids in recommending fertilizer applications.

Whether or not such tissue tests would be of diagnostic value for crops grown under Minnesota conditions has not been determined. The preliminary study reported here was made to determine the association between nutrient content of leaf petioles at various stages of growth as obtained by rapid chemical tests and yields of potatoes grown under various levels of soil fertility.

MATERIALS AND METHODS

All potatoes were grown at Brooklyn Center on a soil which has been classified as a Hubbard loamy sand (14). Previous fertilizer trials had shown this soil to be deficient in nitrogen, and soil analyses using methods devised by Purvis and Blume (17) indicated that the soil was

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"low" in Ca, Mg, NH_4-N, and NO_3-N, "medium" in P and "medium" to "high" in K. The pH of the soil was 5.76. The tests for Al were negative.

The fertilizer treatments applied were as follows:

Treatment	Lbs. per Acre N	Lbs. per Acre P_2O_5	Lbs. per Acre K_2O
1	0	160	160
2	80	160	160
3	160	160	160
4	160	0	160
5	160	80	160
6	160	160	0
7	160	160	80
8	0	0	0

Nitrogen was supplied in the form of 20 per cent ammonium sulphate, potash in the form of 60 per cent muriate of potash, and the phosphate in the form of 43 per cent superphosphate.

On the 15th of April, deep furrows were opened, the fertilizers were scattered in the bottom of the furrow by hand, two inches of soil were raked over the fertilizer, and potato seed pieces of the Cobbler variety were planted on top of this soil and covered. Each of the fertilizer treatments was applied to four randomized plots, each plot being a single, two-rod row containing 20 seed pieces spaced 18" apart in the row. To avoid possible fertilizer effects from adjacent plots, single, unfertilized rows of potatoes were planted between treatment plots.

Leaf petiole samples for chemical analysis were taken on the 5th, 17th, and 24th of June, and on the 1st, 8th and 15th of July. On the 5th of June plants had 6-10 leaves; on the 17th flower buds were apparent in all plots; and on the 24th plots were in full bloom except those in minus N plots which were about one week late in blooming. All samples were taken between 8:30 and 9:30 a. m. The plant sample taken for chemical analysis consisted of the sixth leaf from the growing tip of the primary stems of 5 to 10 plants. All samples were immediately brought to the laboratory where the leaflets were stripped off, the remaining 10-15 grams of petioles were then cut into pieces 2 to 3 mm. in length, and the plant sap extracted from a 5-gram sample by the method outlined by Carolus (3). All extracts were stored in a refrigerator at 1-2°C. until analyses were made.

The procedures for determining the soluble N and soluble P content were those used by Carolus (3) with the exception that only 0.5 ml. of extract was used for each determination and the readings made by the

use of a Klett-Summerson photo-electric colorimeter equipped with a No. 42 blue filter. The procedure outlined by Carolus (3) for the determination of the potash (K_2O) content was used in modified form. To 2 ml. of the diluted extract were added 2 ml. of cold 0.5 N sodium acetate followed by the addition of 0.5 ml. of cold 0.1 N sodium hydroxide. After thorough shaking, 0.25 ml. of a 0.25 per cent solution of gum arabic, 0.5 ml. of cold 10 per cent sodium cobaltinitrite, and 5 ml. of cold 95 per cent ethyl alcohol were added in that order. After thorough shaking for 30 seconds the solution was allowed to stand for 4 minutes after which the sample was read in the photoelectric colorimeter using the No. 42 blue filter. The standards used (3) were run through the same procedure as the unknown samples. It was found that in order to obtain reproducible readings it was necessary to keep all reagents at approximately 7°C. The sodium acetate buffered the solution between pH 5.7 and 6.0 and the gum arabic prevented too rapid settling of the precipitate and thus allowed the use of the colorimeter.

RESULTS

The soluble N contents of leaf petioles, and yields of potatoes grown under the eight fertilizer treatments are given in table 1. Nitrogen applications to the soil used in this experiment approximately doubled the yields of potatoes obtained. However, increasing the nitrogen application from 80 pounds to 160 pounds per acre did not result in further

TABLE 1.—*Soluble nitrogen content of potato leaf petioles at successive stages of growth, and yields of potatoes, following application of eight fertilizer mixtures.*

Nutrients Applied per Acre			Soluble N in Leaf Petiole Tissue on Indicated Dates:						Yields of Tubers per Acre
N	P_2O_5	K_2O	6/5	6/17	6/24	7/1	7/8	7/15	
Lbs.	Lbs.	Lbs.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	Bushels
0	0	0	413	300	274	263	216	218	81
0	160	160	352	282	230	241	228	234	88
160	160	160	850	725	520	432	426	441	169
160	0	160	822	652	460	405	409	528	171
160	160	0	797	624	532	456	455	484	172
80	160	160	769	546	505	384	346	388	173
160	80	160	766	616	466	433	397	469	173
160	160	80	691	664	496	442	382	429	189
Diff. necessary for odds of 19:1			141	136	107	93	71	60	32

increase in yield. The soluble nitrogen content of leaf petioles from plants in nitrogen-fertilized plots was approximately double that in plants from unfertilized plots. Increasing the soil application of nitrogen from 80 pounds to 160 pounds per acre did not significantly increase the nitrogen content in the plants.

The effects of phosphate and potash fertilization on the nitrogen content of potato leaf petioles are best shown in the three sets of graphs across the top of figure 1. Omitting nitrogen from the fertilizer applied resulted in greatly reduced nitrogen content in the plants. Omitting either phosphate or potash from the fertilizer, however, had no effect on the nitrogen content of the plant.

Variations in the soluble phosphorus content of plants grown under the eight fertilizer treatments are given in table 2. The more important

TABLE 2.—*Soluble phosphorus content of potato leaf petioles at successive stages of growth and yields of potatoes following application of eight fertilizer mixtures.*

Nutrients Applied per Acre			Soluble P in Leaf Petiole Tissue on Indicated Dates:						Yields of Tubers per Acre
N	P_2O_5	K_2O	6/5	6/17	6/24	7/1	7/8	7/15	
Lbs.	Lbs.	Lbs.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	Bushels
0	0	0	490	575	638	510	517	371	81
0	160	160	564	614	653	506	588	494	88
160	160	160	327	388	376	324	278	184	169
160	0	160	259	313	245	122	123	99	171
160	160	0	285	332	345	236	243	171	172
80	160	160	324	380	357	331	248	172	173
160	80	160	287	343	340	232	168	133	173
160	160	80	269	312	345	269	250	236	189
Diff. necessary for odds of 19:1			84	67	107	103	127	111	32

effects of variations in nutrient supply on phosphorus content are shown in figure 1 in the center row of graphs. Plants which had received no nitrogen fertilizer contained the greatest quantities of soluble phosphorus. These results are in agreement with those found by Carolus (3) and others (1, p. 43) for potatoes and Emmert (8) for tomatoes. In the absence of adequate nitrogen supply, the application of phosphate and potash had no significant effect on soluble phosphorus content. However, in the presence of adequate nitrogen supply, the application of phosphate significantly increased the phosphorus content of plants,

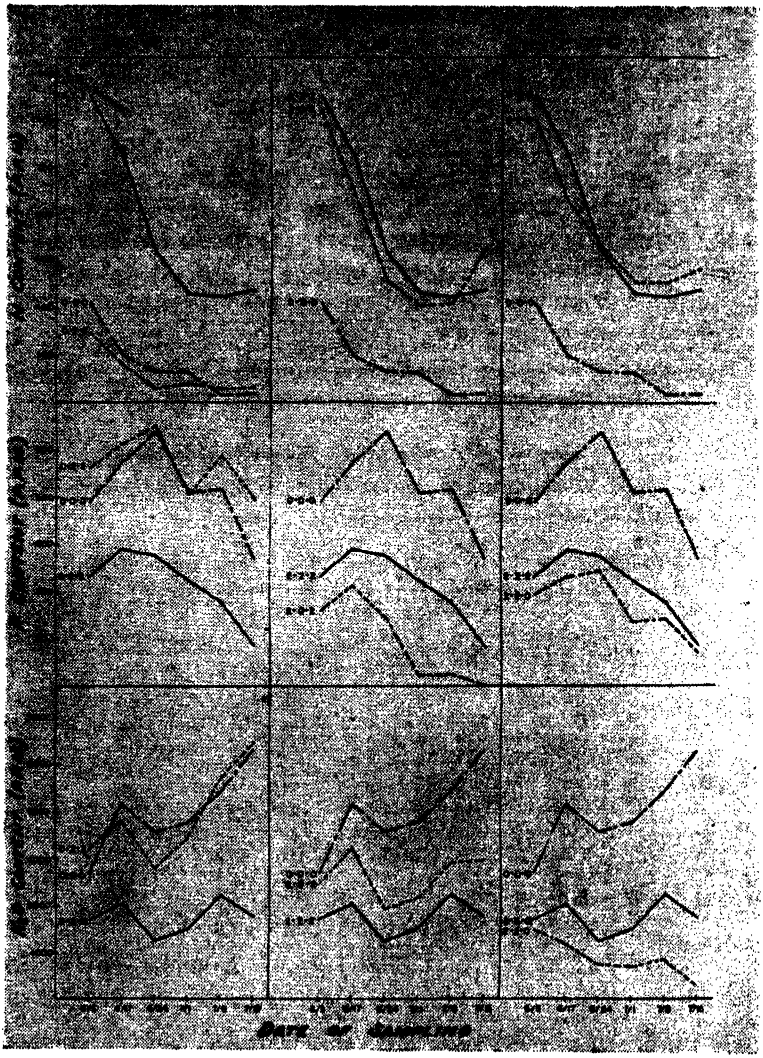

FIGURE I—N, P, and K2O content of potato leaf petioles at successive dates under different levels of N P, K supply. (The fertilizer ratio applied is indicated at the left of each curve; 2-2-2 indicating 160 lbs. N, 160 lbs. P2O5, and 160 lbs. K_2O respectively.

whereas potash fertilization had no significant effect on phosphorus content. MacGregor and Rost (13) and Lucas, *et al* (12) found that phosphate fertilization had little effect on phosphorus content of pota-

toes, whereas Lorenz (11) and Carolus (3) found that phosphate fertilization markedly increased the phosphorus content of young plants.

Table 3 shows the soluble potash content of potato leaf petioles at successive stages of growth following the application of the eight fertilizer mixtures. In figure 1, bottom row of graphs, are shown the more important effects of variations in nutrient supply on potash content. Plants which had received no nitrogen contained the greatest quantities of soluble potash. These results agree with those obtained by Knowles and Watkins (10) and Carolus (3) with potatoes and Phillips, *et al* (16) with tomatoes. Under conditions of low nitrogen supply, the application of phosphorus and potash fertilizer had no significant effect on potash content. However, under conditions of high nitrogen supply, withholding phosphate fertilizer significantly raised the level of potash in the plant, whereas withholding potash fertilizer significantly reduced the potash content of plants.

Examination of the graphs in figure 1, indicates inverse relationships between the nitrogen content and the phosphorus and potash content of potato leaf petioles. Correlation coefficients calculated for the data obtained on the sampling dates 6/5 and 7/15 confirm this:

Correlation between	"r" for 6/5 Data	"r" for 7/15 Data
N and P	—.926**	—.964**
N and K_2O	—.633	—.819*
P and K_2O	+.735*	+.703

The negative correlations obtained between N content and P content were highly significant for both dates. The negative correlation between N and K_2O contents approached significance for the data obtained on 6/5 and was significant at the 5 per cent level for the data obtained on 7/15. The positive correlation coefficient between P and K_2O content was statistically significant for the 6/5 data and approached significance for the 7/15 data.

Discussion

In the study here reported, the yield data indicate that the soil in which the potatoes were grown was deficient in nitrogen. An application of 80 pounds of nitrogen per acre approximately doubled the yield of tubers. This application of nitrogen also approximately doubled the nitrogen content of the plants. The differences in nitrogen content of N-fertilized and unfertilized plants were present at least as early as the 5th of June, eight weeks after planting or about four weeks after

emergence of the plants. The plants at this time had 6-10 leaves. At this stage of growth, the leaf petioles of N-fertilized plants contained 850 p.p.m. of soluble N, whereas plants not receiving nitrogen contained 350 p.p.m. Two weeks later, when plants had visible flower buds, N-fertilized plants contained 725 p.p.m. of N as compared to 280 p.p.m. in minus N-fertilized plants. For the period during which leaf samples were analyzed (6/5 to 7/15) the N-fertilized plants ranged in N content from 850 to 441 p.p.m. whereas the N content of plants not receiving N fertilizer ranged from 352-234 p.p.m The fact that increasing the quantity of nitrogen fertilizer applied from 80 pounds to 160 pounds per acre raised the range in nitrogen content from 769-388 p.p.m. to only 850-441 p.p.m. without resulting in further increases in yield indicates that the 80-pound application was adequate under the conditions of this experiment and that a nitrogen content of 600 to 700 p.p.m. at the time of first visible flower buds was an adequate level of N in the plant for maximum yields.

That the phosphorus content of the soil used in this study was adequate for good yields of potatoes is indicated by the fact that applications of phosphate had no beneficial effects on yields. The inverse relationships found between phosphorus content and the nitrogen content of plants were also obtained by Emmert (8) and Carolus (3). Emmert (8) states that the negative correlations in his tests between yields and the phosphorus content of tomato plants were "undoubtedly due to accumulations of phosphorus not used by the plants because some other factor has stopped or retarded growth." It can be safely assumed that, in this experiment the accumulation of phosphorus in leaf petioles was associated with the retardation of growth due to nitrogen deficiency. Carolus (3) indicates that the "phenomenon of soluble phosphorus accumulation in nitrogen deficient plants may usually be used as a check on a nitrogen deficiency." From the data in table 2 it appears that a soluble phosphorus content of 300-400 p.p.m. at the time of first visible flower buds was adequate for the production of maximum yields under the conditions of the experiment reported here.

As in the case of phosphorus, an inverse relationship between potash content and nitrogen content was found in this study. Apparently, potash also accumulates in plants whose growth has been retarded due to some other limiting factor. That the potash supply in the soil used in this study was sufficient to produce a maximum crop is indicated by the fact that an application of potash fertilizer did not result in increased yields when other growth factors were not limiting. Under the conditions of this experiment a potash content, in the leaf petioles, of

TABLE 3.—*Soluble potash content of potato leaf petioles at successive stages of growth and yields of potatoes following application of eight fertilizer mixtures.*

Nutrients Applied per Acre			Soluble K_2O in Leaf Petiole Tissue on Indicated Dates:						Yields of Tubers per Acre
N	P_2O_5	K_2O	6/5	6/17	6/24	7/1	7/8	7/15	
Lbs.	Lbs.	Lbs.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	P.p.m.	Bushels
0	0	0	5680	7180	6560	6750	7420	8290	81
0	160	160	6180	6780	5800	6430	7710	8470	88
160	160	160	4710	5030	4260	4510	5230	4780	169
160	0	160	5450	6210	4930	5160	5910	5970	171
160	160	0	4490	4210	3760	3690	3860	3300	171
80	160	160	5750	6160	5630	5540	6040	6530	173
160	80	160	4750	5420	4010	4710	5420	5580	173
160	160	80	4310	4610	4000	3720	4870	4390	189
Diff. necessary for odds of 19.1			780	920	1050	560	1340	1190	32

4200 to 6200 p.p.m. at the time of first visible flower buds was adequate for the production of gold yields of tubers.

SUMMARY

1. The effects of soil applications of nitrogen, phosphorus, and potash fertilizers on the soluble nutrient content of potato leaf petioles and on yields of tubers were studied. Rapid tissue tests were used to determine the nutrient content of leaf petioles at successive intervals during the growing season.

2. Soil applications of nitrogen fertilizer at the rate of 80 pounds or 160 pounds per acre approximately doubled the N content of potato leaf petioles and doubled the yields of tubers. The concentrations of soluble P and K_2O were found to be inversely correlated with the soluble N content of potato leaf petioles.

3. Soil applications of phosphate fertilizer had no effect on yields of tubers, nor on soluble N content of potato leaf petioles. Under conditions of high N supply, application of phosphate fertilier resulted in significantly higher P content and in slightly lower soluble K_2O content of leaf petiole tissues.

4. Soil applications of potash fertilizer had no effect on yields of tubers nor on the soluble N content of potato leaf petioles. Under conditions of high N supply, application of potash fertilizer resulted in significantly higher soluble K_2O content but had no effect on soluble P content of leaf petiole tissues.

5. Under the conditions of this experiment, the maximum yields

were obtained when the soluble N content of the leaf petioles at the time of first visible flower buds were 600-700 p.p.m.; the soluble P content was 300-400 p.p.m.; and the soluble K_2O was 4200-6200 p.p.m.

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CURRENT RESULTS WITH POTATO VINE[1] KILLERS IN PRINCE EDWARD ISLAND[2]

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Killing the potato vines prior to harvesting the crop is a practice in modern potato culture that is annually being adopted by increasing numbers of Prince Edward Island growers. This practice has become so firmly established in this province that the majority of growers are now using vine-killing chemicals for one or more of the several purposes (1, 3, 5) for which they have been developed. The growers have readily accepted the local recommendation to treat all fields in which the vines are green not later than the 1st of October. This recommendation was designed to advance the date of digging and thereby reduce the number of oversized tubers in a year with an extended growing season, to permit harvesting of the crop before the advent of inclement weather or freezing temperatures, and to reduce the incidence of late blight tuber rot. In connection with it, growers are advised to delay harvesting until at least ten days after the death of the vines. During this period the tubers loosen from the stolons and the skin matures or toughens, rendering the potatoes less susceptible to mechanical injury during digging and subsequent handling. The Sebago, in particular, is easily bruised. It is recommended that this variety be left in the ground three or four days longer than the other varieties grown in the province.

A great deal of rot, especially in Sebagos, developed in the 1946 crop while in storage and in transit. An extensive survey revealed that the heavy losses were caused by *Fusarium sambucinum* f.6, which gained entrance into the tubers through cuts, wounds, and abrasions inflicted during harvesting operations. The autumn of 1946 was unusually mild and open, and chemicals for destroying the vines were in short supply. Consequently, many fields were dug while the plants were still green. The tubers harvested under these conditions were very easily bruised, even by light blows, as the skin was still immature.

Experiments with a number of chemicals and commercial herbicides (1) have been conducted at the Dominion Laboratory of Plant Pathology at Charlottetown and in growers' fields since 1941. The laboratory plots

[1]Contribution Number 937 from the Division of Botany and Plant Pathology, Science Service, Department of Agriculture, Ottawa.
[2]Assistant Plant Pathologist.

for the 1947 tests were planted on the 11th of June and treated on the 8th of September—the variety used being Green Mountain. The plants, at time of treatment, were disease-free and exceptionally luxuriant and vigorous. Although the sprays were applied at a pressure of 300 pounds, and the machine was equipped with four nozzles per row and driven both ways of the rows, it was difficult to cover the heavy mass of growth completely. The weather on the 8th of September and for the ensuing week was probably ideal for the killing tests. Weather data are presented in table 1.

A summary of the effectiveness of the materials tested is given in table 2. The very marked increase in the toxicity of sodium arsenite sprays, represented in table 2 by Handy Killer, that the addition of an oil made, was the most outstanding feature of the experiment. Preliminary tests, conducted in the greenhouse during the winter, clearly indicated that potato vines were more readily destroyed by a solution of sodium arsenite when an oil was included in the spray. Tests conducted in field plots early in August substantiated the results obtained in the greenhouse, and waste crank case oil was found to be just as effective as miscible oil. Tests were made with three sodium arsenite vine killers—Handy Killer, Green Cross Top Killer, and Geigy's Potato Vine Killer—and it was noted that equal amounts of waste crank case oil increased the toxicity of each to the same extent. Various procedures for mixing the components were studied and it was found that the most effective spray was obtained by stirring the commercial concentrated solution of sodium arsenite and oil together, adding the resulting mixture to the sprayer tank, and finally adding the water while the agitators were turning. This method of preparation emulsified most of the oil. Excellent kill was obtained when the vines were sprayed with a mixture containing one quart of a sodium arsenite vine killer and two gallons of waste crank case oil in forty gallons of water. Several farmers were asked to compare a sodium arsenite solution with a sodium arsenite-oil mixture, and all reported better results with the latter preparation.

The plots were harvested on the 22nd of September, tubers were examined for discoloration at the stem-end and in the vascular ring, and a bushel sample from each plot was put in storage for later examination. No discoloration was found in the tubers of the check plots, but the samples from the treated plots showed varying degrees of browning as shown in table 3. The incidence of browning under the point of stolon attachment was apparently correlated with the rapidity of the kill: the chemicals that caused the most rapid kill in-

TABLE 1.—*Weather data for period of top killing, 1947.*

	Sept. 8	Sept. 9	Sept. 10	Sept. 11	Sept. 12	Sept. 13	Sept. 14	Mean
Min. Temp.	48	57	62	68	55	63	66	59.9
Max. Temp.	68	66	83	86	80	67	74	74.9
Hours Sun	10.4	8.3	8.7	9.6	9.6	10.3	5.5	9.0
Precipitation	0.03	—	—	—	—	0.14	—	—
Rel. Humidity	67	71	83	82	79	81	81	77.7

TABLE 2.—*Comparison of the effect of vine killers, 1947*

Treatment	Number of Days after Application			
	1	2	4	6
Handy Killer 2 qts — 80	Moderate leaf burn.	70 per cent leaves burned.	All leaves dead. Stems green.	Stems green.
Handy Killer + oil[1] 2 qts. + 4 gals. — 80	Pronounced leaf burn.	90 per cent leaves burned.	All leaves dead. Stems green.	Dead.
Green Cross Top Killer. 2 qts. — 80	Moderate leaf burn.	80 per cent leaves burned.	All leaves dead. Stems green.	Stems green.
Krenite 2 gals — 80	Moderate leaf burn.	Moderate leaf burn.	70 per cent leaves burned.	Not satisfactory.
Krenite + oil. 1 gal. + 4 gals. — 80	Slight leaf burn.	Moderate leaf burn.	65 per cent leaves burned.	Not satisfactory.
Dowspray 66 1 gal. — 80	Severe leaf burn.	All leaves dead. Stems green.	Stems green.	Some stems green.
Dowspray 66 2 gals — 80	Very severe. leaf burn.	All leaves dead. Stems green.	Most stems dead.	Dead.
Sinox W 1 gal. — 80	Severe leaf burn.	90 per cent leaves burned. Stems green.	All leaves dead. Stems green.	Some stems green
Sinox General + oil. 1 qt. + 3 gals. — 80	Severe leaf burn.	All leaves dead. Stems green.	Most stems green.	Dead.

[1]Waste crank case oil was used in all sprays in which oil is mentioned.

duced the most pronouncel effects. A similar tendency was reported by Hoyman (2) and Richardson (4), and was observed in experimental material at Charlottetown in 1946. (1). Discoloration of the vascular ring beyond the extreme stolon end occurred in tubers from plots treated with dinitro sprays, but was not found in tubers from other plots. A few tubers from plots sprayed with Krenite (sodium dinitro ortho cresylate) showed a faint browning of the vascular ring, but, as shown in table 2, the plants treated with this material were only partially killed. Browning of the vascular ring was somewhat more pronounced in tubers from plots treated with Sinox General (dinitro ortho secondary amyl phenol) and Sinox W (ammonium dinitro ortho secondary butyl phenol), but the tubers from plots treated with Dowspray 66 Improved (dinitro ortho secondary butyl phenol) were severely affected, in some tubers the vascular ring being discolored as far as midway to the eye end. In table 4 are presented the results of the examination made on the stored tubers during the last week of November. The differences among the samples had largely disappeared, except for the samples from plots treated with Dowspray 66 Improved. Discoloration, especially in the vascular ring, was very prominent in the stored tubers from the plots treated with this chemical. Cooking tests were conducted at this time, but no differences in flavor or texture of the flesh were discernible among the tubers from the several treatments.

Steinbauer (5) reported that slight discoloration of the vascular bundles sometimes occurs in Maine subsequent to the application of vine killers, especially dinitro compounds, and Hoyman (2) observed a brown discoloration of the vascular tissue two days after the application of Dowspray 66 Improved. Similar injury was observed in Ontario (1,4) in 1946, but not in Prince Edward Island (1). The very considerable difference in the amount and intensity of the discoloration induced by Dowspray 66 Improved in the Charlottetown tests of 1946 and 1947, suggests the possibility that some presently unknown factor, perhaps seasonal, may have an influence on the results. It should also be noted that, although several workers on this continent have reported a discoloration of the vascular tissue of tubers following the destruction of the plants by chemical vine killers, no such phenomenon has been observed in Britain (6). The summer season—July, August, and September of 1947 was characterized by a higher mean temperature, more sunshine, and less rain than the corresponding period of 1946. July and August were unusually dry months, rainfall being below the average for these periods, and the mean temperature for

TABLE 3.—*Amount of intensity of discoloration in tubers in fourteen days after application of vine killers, 1947.*

Treatment	Concentration per 80 Gals.	Per cent Free	Per cent Incipient	Per cent Moderate	Per cent Severe	Rating
Check (tops green)	—	50	50	0	0	5.0
Check (tops dead)	—	—	—	—	—	—
Tops cut off	—	8	36	48	8	12.4
Handy Killer	2 qts.	28	48	24	0	8.4
Handy Killer + oil[1]	2 qts. + 4 gals.	2	46	46	6	12.7
Green Cross Top Killer	2 qts.	6	54	38	2	11.5
Krenite	2 gals.	18	40	38	4	10.5
Krenite + oil	1 gal. + 4 gals.	22	64	14	0	8.5
Dowspray 66	1 gal.	0	12	48	40	16.4
Dowspray 66	2 gals.	0	2	46	52	17.5
Sinox W	1 gal.	2	32	56	10	13.6
Sinox General + oil	1 qt. + 3 gals.	2	42	48	8	13.0

[1]Waste crank case oil was used in all sprays in which oil is mentioned.

TABLE 4.—*Amount and intensity of discoloration in tubers after two months in storage, 1947.*

Treatment	Concentration per 80 Gals.	Per cent Free	Per cent Incipient	Per cent Moderate	Per cent Severe	Rating
Check (tops green)	—	2	69	27	2	11.3
Check (tops dead)[1]		7	77	14	2	10.2
Tops cut off	—	1	38	53	8	13.3
Handy Killer	2 qts.	0	78	19	3	11.2
Handy Killer + oil[2]	2 qts. + 4 gals.	1	68	27	4	11.6
Green Cross Top Killer	2 qts.	0	70	24	6	11.8
Krenite	2 gals.	0	47	45	8	13.0
Krenite + oil	1 gal. + 4 gals.	0	58	37	5	12.3
Dowspray 66	1 gal.	0	21	39	40	15.9
Dowspray 66	2 gals.	0	19	37	44	16.2
Sinox W	1 gal.	2	58	23	17	12.6
Sinox General + oil	1 qt. + 3 gals.	0	43	41	16	13.6

[1]Dug later, after plants had been killed by frosts
[2]Waste crank case oil was used in all sprays in which oil is mentioned.

July was the highest ever recorded for this month. Weather data for the summer months of 1946 and 1947 are presented in table 5.

It has been suggested that among other factors (1), the stage of development of the plant at the time of killing might have a bearing on the incidence of vascular discoloration in the tubers. In 1947 randomized and replicated plots of Green Mountains were treated with Dowspray 66 Improved on the 11th and 27th of August and on the 8th and 22nd of September which is 61, 77, 89, and 103 days, respectively, after planting. The chemical was used at a concentration of two gallons in eighty gallons of water and applied in the same way as that described above. Fourteen days after each application, the tubers were lifted and examined by removing one or more slices from the stolon end.

The results of these examinations are shown in table 6, in which it is indicated that the severity of the discoloration increased quite regularly from the first to the last killing of vines. It was also observed that the plants were killed more quickly as the season advanced, an observation that again suggests the possibility that the phenomenon is correlated with the rapidity of the kill.

Summary

1. Dowspray 66 Improved and Sinox General were the most effective potato vine killers tested at Charlottetown in 1947.

2. Sodium arsenite herbicides killed the vines slowly, several days being required to accomplish the death of the plants, but the addition of oil, such as fuel oil, a miscible oil, or waste crank case oil, resulted in mixtures that destroyed the vines as quickly and completely as Dowspray 66 Improved or Sinox General.

3. The premature killing of vines may induce a discoloration in the vascular tisues of the tubers. Dinitro compounds, especially dinitro ortho secondary butyl phenol, induced the most pronounced discoloration.

4. Tubers harvested from untreated cut vines showed a greater incidence of stem-end discoloration than tubers from untreated check plants, or from plants destroyed by slow acting herbicides.

5. Further data were obtained in support of the theory that tuber vascular discoloration is correlated with the rapidity of the kill.

6. The amount and intensity of discoloration in tubers from plants killed at different stages of development with dinitro ortho secondary butyl phenol increased quite regularly with the age of the plants. Those killed late in the season exhibited the greatest injury.

7. The culinary quality of potatoes was not impaired when the plants were destroyed by vine killers.

TABLE 5.—*Weather data for summer months of 1946 and 1947.*

	July		August		September		Mean	
	1946	1947	1946	1947	1946	1947	1946	1947
Mean temp.	65.0	71.8	65.5	66.3	61.4	59.2	64.0	65.8
Hours—sun	264.1	232.1	189.1	278.6	184.8	212.6	212.7	241.1
Inches—rain	2.63	2.57	4.05	1.34	2.63	4.72	3.10	2.88

TABLE 6.—*Amount and intensity of discoloration in tubers from plants killed at intervals with Dinitro ortho secondary butyl phenol,* 1947.

Date Killed	Per cent Free	Per cent Incipient	Per cent Moderate	Per cent Severe	Rating
August 11	7.3	52.7	30.7	9.3	11.7
August 27	0.0	26.0	52.7	21.3	14.8
September 8	0.0	17.3	46.7	36.0	15.9
September 22	0.0	5.3	51.7	43.0	16.9

Legend of Figures

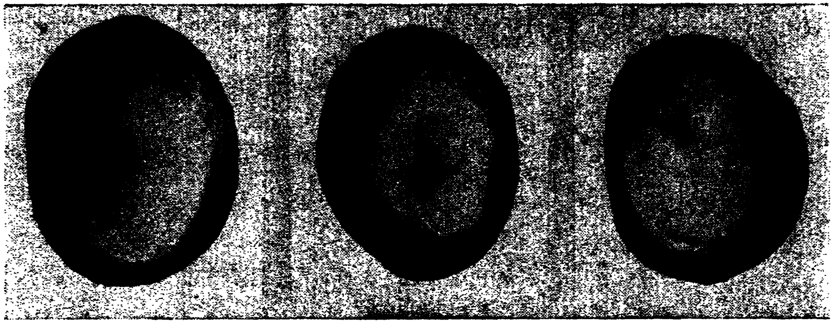

FIGURE 1—Vascular ring discoloration in Green Mountains from vines sprayed with dinitro ortho secondary butyl phenol.

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FIRMNESS OF POTATO VARIETIES AS MEASURED BY A PRESSURE TESTER[1]

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The firmness of flesh of potato tubers as measured by a pressure tester was determined for nine varieties grown at thirteen locations in Minnesota. The results obtained were compared with the dry matter of the samples as measured by specific gravity.

The instrument used for measuring firmness was similar to that described by Magness and Taylor (*1*) for determining fruit maturity. The pounds of pressure required to force a plunger 5/16 of an inch in diameter into a potato tuber to a depth of 5/16 inches was determined. Tests were made at approximately the same position on each tuber. No tests were made in close proximity to the eyes. Prior to testing, a portion of the skin was removed at the point of testing on each tuber. One reading per tuber was taken. Each sample consisted of ten tubers chosen for uniform size and taken from each of two replications of nine varieties grown at thirteen locations. The specific gravity of these samples was determined by means of a wet and dry weight method whereby the specific gravity was calculated by dividing the dry weight of the sample by the loss of weight in water. The dry matter was then determined from tables prepared by Von Scheele *et al* (*2*).

The variances due to variety, location, and the interaction of variety and location for pressure test and for specific gravity and the correlation coefficients as determined by the analysis of covariance are

[1]Paper No. 2384 of the Scientific Journal Series of the Minn. Agr. Exp. Station.

TABLE 1.—*Variances and correlation of pressure test and specific gravity of potatoes.*

Variation Due to	Degrees of Freedom	Variances		Correlation Coefficient (1)
		Pressure Test	Specific Gravity	
Variety	8	82.37**	1079.07**	.4824
Location	12	22.91**	584.43**	.3502
Block	1	.86	.04	—.002
Variety x Location	96	5.25**	16.84**	
Error	103	1.18	7.08	

**Significant at the one per cent point.
(1) Total correlation coefficient 0.316**

given in table 1. The variances due to variety, location, and the interaction of variety and location were highly significant for both pressure test and specific gravity. The association between pressure test readings and specific gravity was significant only in the case of the total correlation. The correlation coefficients for variety and location were of the same order of magnitude as the total correlation. The relatively low total correlation coefficient 0.316 suggests that in addition to dry matter other internal factors influence the firmness of flesh as measured by the pressure tester.

The mean pressure test readings for nine varieties of potatoes tested at thirteen locations are given in table 2. The highest readings obtained were for the varieties Red Warba (21.88), Minn. 6 (21.66) and Minn. 42 (21.37); the lowest readings obtained were for Chippewa (17.24), Chicago (17.82) and Pontiac (17.92); whereas the readings for Minn. 43 (20.73), Waseca (20.22) and Minn. 126 (20.02) were intermediate.

Significant differences between the mean pressure test readings for the thirteen locations are indicated in table 3. The mean for Glyndon (21.87) was significantly higher than the mean for the other locations with the exception of East Grand Forks (21.43).

Significant variances were obtained for the interaction of variety with location. A small part of the data showing some of the interactions

TABLE 2.—*Pressure test readings of nine varieties of potatoes.*

Variety	Mean of Thirteen Locations	Variety	Mean of Thirteen Locations
Red Warba	21.88	Minn. 126	20.02
Minn. 6	21.66	Pontiac	17.92
Minn. 42	21.37	Chicago	17.82
Waseca	20.22	Chippewa	17.24
Minn. 43	20.73		

Difference necessary for odds of 19.1=0.60

TABLE 3.—*Pressure test readings for potatoes at thirteen locations.*

Locations	Mean of Nine Varieties	Locations	Mean of Nine Varieties
Glyndon	21.87	Fertile	19.47
E. Grand Forks	21.43	Fisher	19.22
McIntosh	20.93	Brooklyn Center	19.16
Crookston	20.60	Chicago City	19.00
Halstad	20.39	Carlton	18.46
Kennedy	20.00	Cambridge	18.13
Richfield	19.70		

Difference necessary for odds of 19:1=0.72

of variety with location for pressure test readings is given in table 4. Red Warba was significantly higher than Minn. 6 at McIntosh but lower at Glyndon. Pontiac was significantly higher than Chippewa at Fisher but the reverse was true at Cambridge. The influence of variety and location tended to give wide differences in pressure test readings,

TABLE 4.—*Pressure test readings showing interactions of variety with location.*

Location	Variety			
	Red Warba	Minn. 6	Pontiac	Chippewa
Glyndon	21.95	25.70	20.10	17.35
McIntosh	24.30	22.05	16.65	21.10
Fisher	19.25	20.50	20.30	13.70
Cambridge	22.15	20.20	15.40	18.05

Least significant difference for the interaction of variety with location=3.04.

for example: Minn. 6 at Glyndon gave a reading of 25.70, whereas Chippewa at Fisher gave a reading of 13.70.

The differences obtained in firmness of flesh between variety, location and the interaction of variety by location warrants further study to determine its possible relation to market and culinary quality.

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PLANS FOR THE MAINTENANCE OF VALUABLE FOREIGN AND CERTAIN DOMESTIC POTATO BREEDING STOCKS[1]

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Investigators throughout the country, interested in potato improvement, recognize the need for a better system in order to maintain potato stocks of foreign and domestic origin for breeding purposes. The practice now in operation at the various potato breeding stations involves a compromise between breeding activities for particular objectives and the maintenance of stocks of unknown value or stocks possessing particular attributes which will be needed as the breeding program progresses. Facilities and funds are usually not available to carry along both lines of work equally well. Whenever a choice becomes necessary the maintenance of inactive breeding cultures is relegated to a secondary position or eliminated entirely. The need for a better program to maintain valuable potato germ plasm in this country is well summarized in the following statement made recently in a letter by Morrison, Principal Horticulturist in charge of the Division of Plant Exploration and Introduction, United States Department of Agriculture: "I am sorry, of course, that after all of the work which has been done in getting species of potatoes into this country for the various breeders, that no one has had either the facilities, or the time, or money to maintain the stocks."

It is fortunate that a more orderly program for plant introduction and maintenance has been made possible by the Research and Marketing Act of 1946. One activity suggested for support from this Act is the introduction, maintenance and testing of foreign plant materials. Committees at regional and national levels have been established during the past year to suggest plans and to propose an overall program to maintain desirable germ plasm.

It is now the responsibility of investigators interested in potato improvement to develop a suitable program for the introduction, maintenance, and testing of tuber-bearing species of *Solanum*. A national committee and four regional committees of potato workers including rep-

[1]Paper from the Department of Genetics, No. 378, Agricultural Experiment Station, University of Wisconsin. This paper was prepared for the Report of the Potato Breeding Committee for 1947, Potato Association of America.

resentatives of the Division of Plant Exploration and Introduction of the United States Department of Agriculture should be formed to develop a program for the introduction and maintenance of desirable potato stocks. These committees should determine (1) where heterogeneous collections of potato stocks can be maintained to the best advantage, (2) what facilities and personnel will be necessary, (3) what range and volume of material should be considered, (4) what material is on hand and what new material is desired and (5) the probable cost of an adequate program.

The introduction and maintenance station or stations should, if possible, be located independently of an associated breeding enterprise. This would safeguard the possibility of compromising the objectives to the detriment of the introduction and maintenance program. Furthermore, the introduction station should be located on an isolated farm in a favorable potato seed production area where the spread of diseases is naturally low. Adequate greenhouse, tuber and seed storage, laboratory and office facilities are essential. The plant scientist in charge should possess excellent integrating and coordinating ability and a willingness to cooperate with research workers at various experiment stations. Professional services and guidance in the fields of Plant Pathology, Entomology, Cytogenetics and Taxonomy should be available. Recognition of the susceptibility of the potato plant to numerous diseases suggests the wisdom of two widely separated introduction centers. It would also be highly desirable to establish the introduction stations as centrally as possible in relation to potato breeding projects.

The functional limits of the work to be carried on at the potato introduction stations should be clearly outlined. Stocks eligible for consideration should be indicated and the size of samples for distribution should be limited to very small quantities of tubers or seed. The following stocks might be placed on the eligible list: (1) foreign tuber-bearing species of Solanum; (2) foreign cultivated varieties: (3) minor American varieties not considered by certification agencies; and (4) seedlings possessing outstanding attributes which have been described in publications. A standing potato introduction committee could be exceedingly helpful in establishing an eligibility list of materials now available. Such a committee could also be helpful in arranging for the acquisition of new potato cultures and in discarding inactive stocks of questionable value. It is anticipated that virus infection alone may, under the best possible conditions, reduce many stocks to impotency. Experience with maintenance programs clearly indicates the need to provide for deletions as

well as additions. This will permit the program to continue to serve current requirements and to operate within established budgetary limits.

Recognition of the need for adequate testing of foreign introductions and of the need for a coordinated program among states was a part of the Andresen Bill whose provisions were considered when the Research and Marketing Act was written. The potato introduction committee should logically take an active part in planning a testing program outlined under this project. The various research laboratories might offer to serve as testing stations for certain characters such as blight immunity or early maturity in which they are interested, and with which they are well qualified to deal. The potato introduction and maintenance stations might undertake some testing responsibility, but this feature would readily increase costs and divert attention from their main objective. The stocks maintained at the introduction centers might be catalogued once each year with regard to both favorable and unfavorable characters observed by state and federal research workers.

The potato introduction committee or committees might also serve in a coordinating capacity in regard to the introduction of new foreign material. In the past there has not always been a close contact between the various research laboratories and the Division of Plant Exploration and Introduction. This is exemplified by the news of an expedition being planned at the present time to send Correll to Mexico to collect wild species of potatoes. Information of this type should be made available to every potato research laboratory in the country. Better yet, the research workers who are to use this material should be given an opportunity to make their needs known before a potato collecting expedition is planned.

The potato introduction committee might contact research workers regarding the need for new materials at definite intervals and might transmit these requests to the Division of Plant Exploration and Introduction. Plant explorers may, from time to time, learn about foreign potatoes which should be brought to the attention of American workers. Such information, too, could readily be made available through the potato introduction committee.

SECTIONAL NOTES

Maine

Our planting season is about one week ahead of last year. About the 10th of May we experienced fine weather when about 50 per cent of the potatoes were planted. The next nine days we experienced rain which has been followed by very good weather. Many farmers; however, are reporting some loss of seed in low spots. These spots vary from 2 rods to 20 acres in size. In the aggregate, the loss will not be large but it is serious for those unfortunate farmers.

Practically every farmer is staying within his potato allotment, even though to date the method of supporting prices after January has not been officially declared. Maine's allotment is approximately 185,000 of which Aroostook County alone has 168,995 acres.

A committee has already been appointed to make plans for the field meeting of the Potato Association of America which will be held in August. A big crowd is expected, and those attending may be assured of a typical Aroostook welcome. Maine potatoes are worth seeing in August.

The Farm Bureau Day is planned for Experimental Farm at Presque Isle on the 12th of August. Machinery exhibits will feature this Field Day.

Japanese millet is being grown by a great many farmers this year as a green manure crop. Because of its weed-controlling properties, it has made rapid strides in acreage during the past two years.

Some experimental work this spring, with pre-emergence sprays in potatoes for weed control, looks promising. Those who are interested might have a chance to see these if they attend the field meeting of the Potato Association of America.—Verne C. Beverly.

Nebraska

We will see a few potatoes planted this week, with the bulk of the late planted crop going into the ground between the 10th and 20th of June. Moisture conditions throughout the High Plains area of western Nebraska are excellent at this writing. A few growers are complaining that they are being held up with their plowing because of excessive moisture. However, this is an uncommon complaint.

The acreage of certified potatoes is expected to drop to a certain extent, possibly 9,000 acres for 1948. This is the second year that has shown a reduction, and reflects the competition of such crops as dry, edible beans under irrigation, and winter wheat on the dry land areas.

The two crops mentioned can be grown wholly mechanically, plus the fact that high prices have been obtained consistently for several years. A resume of the 1947 crop indicated that table potatoes brought almost as much as certified seed. This does not mean that certified potatoes were in disfavor, but extremely high prices for table stock were obtained throughout most of the season. This high level price for table stock made it very difficult to maintain a premium on certified seed, and consequently, approximately one-half of the certified seed crop was diverted to table stock channels.

The early crop of table stock production in the Gibbon-Kearney-Cozad section, along the Platte River, was planted the first part of April, following a late spring caused by snow and rains during March. Ground and weather conditions were unfavorable at the time, and serious rotting of seed pieces, took place. Many growers reported poor stands, some to the extent that it was practical to rework the fields and plant with another crop. Owing to the shortage of seed potatoes at that time, corn was being used for the replacement. The acreage of potatoes planted in that area is shorter than last year, and, according to present information the acreage of non-certified potatoes in western Nebraska will be slightly higher than last year.—MARX KOEHNKE.

NEW JERSEY

Excessively heavy rainfall throughout the state since planting time has caused serious fertilizer deficiencies in certain fields. The most evident deficient elements are nitrogen and magnesium. Numerous fields will produce below average yields but the crop in general is making satisfactory growth. Many growers have been prevented from cultivating or spraying because of the wet fields. This has resulted in excessive weed growth, inadequate hilling of the plants, and poor fungicidal protection which will in turn cause reduced yields, more greening of the tubers later in the season and the possible development of serious late blight infection. Many growers have resorted to dusting their fields by airplane as a means of protecting the plants from late blight and insect injury.

Late blight was found in localized sections of three widely separated fields during the last week in June, but it is not general or serious as yet. A few days of dry weather together with thorough spraying or dusting with copper should prevent these infections and prevent its spread.

Harvesting of cobblers will probably begin, in a small way, about the 12th of July.—JOHN C. CAMPBELL.

NEW YORK

Up-state New York Growers have just about finished planting. The acreage is probably less than their goal.

The Long Island acreage reported up to allotment with the crop growing rapidly. Wet weather during the last one-half of May over the whole state retarded planting in up-state areas and also cultivation on Long Island.

New York growers are watching anxiously for developments of washing machines on the southern potatoes. One washing plant is being installed on Long Island which will be closely watched by growers in the Northeast.

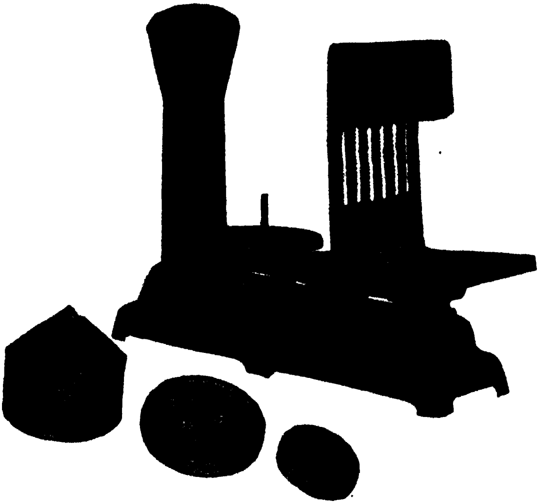
Much interest is manifest on the position of potatoes in regard to current legislation. The attitude of New York growers is that 90 per cent parity was too high and that 60 per cent would be considered as good insurance and would probably produce enough potatoes.

Much interest is expressed in the grade qualifications for eligible growers in the present potato program. Although all growers agree that low grade potatoes hurt the market they are concerned about what to do with these grades in case the Government does not allow shipment. To meet the problem, a large dehydrator is installed and ready for business at Avoca which can turn out large quantities of potato meal.

One of the biggest public demonstrations of farm machinery will be staged at the Summer meeting of the Empire State Potato Club which will be held the 12th of August on the farms of J. W. Hopkins & Son and Irving N. Hopkins at Pittsford, New York, which is 10 miles South of Rochester in Monroe County and the center of an extensive farm area. These two farms grow more than 700 acres of cash crops each year including some certified grain. A full program is being arranged with the cooperation of the Department of Agricultural Engineering and the extension staff at the College. Herb Johnson of the Monroe County Farm Bureau is general chairman. This is probably the biggest meeting of this kind in the country and is looked forward to as an annual event by growers from many states besides New York.—H. J. EVANS.

NORTH CAROLINA

Like the other early commercial potato areas in the southeast the plantings in North Carolina were late because of adverse weather. However, the conditions were good after planting and generally the crop was superior to that of 1947 until the latter part of May. Late blight was found first in Pamlico County about the 16th of May. The weather since



that time has been cool, with frequent rains. The spread has been fairly general over the coastal counties. The potato crop is made, but there is considerable concern over the late blight infection reaching the tubers. Some of the growers are using defoliants and rotobeaters to kill the tops before harvesting. The success of these practices and the general degree of tuber infection will depend largely on the weather during the next two weeks.

The picture is further complicated by the market situation. The North Carolina growers voted in the Marketing Agreement which took effect Friday night, the 4th of June. Under these regulations only U. S. No. 1's can be sent out of the state. The southeastern potato committee is now administering this Agreement.

The movement of potatoes thus far is approximately 1500 cars. Our yields are reported to be higher than last year and the quality good. The price has been around support level or slightly below. The reduction in acreage and yield in South Carolina have had no effect on the market situation here. This reduction is more than offset by the increase in California and by late shipments from South Carolina. In addition, Eastern North Carolina and the Eastern shore of Virginia will market much of their crops during the same period. It is generally felt that a high percentage of potatoes in this area will be moved on the support program this year.—Fred D. Cochran.

South Dakota

Early planted potatoes in South Dakota are now up and many fields have been cultivated for the first time. The stands are exceptionally good and the fields are clean since May was a very dry month with moisture far below normal. Good rains have been received at this writing, the 7th of June, and the potato crops are in excellent condition.

Applications for certification are now coming in and the acreage will be about the same as last year when 6,350 acres were entered for certification.

A meeting to nominate committee men to administer the potato marketing program will be held in Watertown, on the 14th of June. The potato marketing agreement will cover six counties in the northeastern part of the state and all potato growers in these counties have been invited to attend the meeting. R. E. Keller of Chicago will help with the elections.—John Noonan.

Virginia

By this time you have probably heard of the panic which recent cool, rainy weather has caused potato growers in North Carolina and the Norfolk section of Virginia. We have had a super-abundance of rain and the weather has remained unusually cool for this time of the year. Late blight is spreading like wildfire in many fields which were either not dusted with copper or where the copper dust was washed off by heavy rains. In addition, in certain low-lying fields, standing water has rolled the potatoes in the ground. We have heard of a few fields which are a complete loss—where it is impossible to find a sound potato left in 20 feet of row. Some pessimists estimate that in the Norfolk section nearly 25 per cent of our potential production will be lost by the blight killing vines two weeks before digging time. The situation probably is not quite that bad, but all agree that they have never seen the weather turn the best potato crop prospects in history into almost the worst,—within a period of approximately one week.

Our Norfolk section dealers and growers are fearful that the blight news concerning our potato crop will scare off many prospective buyers. They hasten to explain that there are many fields which have not been touched so far by blight. These are mostly fields where a careful and continuing program of dusting with copper was followed. They point out that the commercial trade can buy plenty of blight-free potatoes in the Norfolk section. Because of the tremendous production in late spring and early summer states, we expected to sell nearly 50 per cent of our crop to the government in Virginia anyway. Of course, Virginia growers feel that over-planting in California is the principal reason for this.

The Eastern shore of Virginia—which has about 27,000 of our 35,000 acres of early commercial potatoes—has not as yet been hit by blight as has Norfolk section. There is a little blight showing up in lower Northampton County on the shore, but now that the rains seem to have ended, this is not expected to spread. In addition, Eastern Shore growers seem to have followed a more consistent program of dusting with copper. The land on the Eastern Shore is more uniformly sandy, high, and well-drained than that on the Norfolk section also. Normally, however, yields and returns per acre on potatoes are higher in the Norfolk section than on the Eastern shore.

For that portion of our potatoes which will be harvested in good condition in the Norfolk section, we are going ahead with plans to put up the fanciest grade and pack than has ever been tried on a large commercial scale in this country.

Mr. G. W. Capp's 7 potato washers and driers which cost $15,000 apiece and Mr. J. H. Baker's one machine which cost nearly as much are set up and ready to go. A few potatoes have already been run through them. The new $250,000 packing shed at Euclid, Virginia, just south of the Virginia Beach Boulevard at Chinese Corner which houses six of Mr. Capp's seven machines is completed. Automatic conveyors are set up by all machines to load 10 and 15-pound bags directly into cars from the machines. About 65 per cent of Mr. Capp's production will be U. S. Extra No. 1's 2¼" to 3" size. All No. 1's between 1⅞" and 2¼" and all 3" will be run into another pack and probably most of them will go to the government. Mr. Capp's has some very fancy 10 and 15-pound bags which are heavy double paper with a visionette window. The capacity of his tremendous packing shed is 150 cars per day—operating on a 20-hour day which he will maintain during June and July. He can load about 50 cars at one time from his shed. His operation is a real site to behold and many out-of-state as well as state visitors have already come to see it. The Eastern Shore of Virginia has no washers and driers this year, but Mr. Capp's plans to handle many Eastern Shore potatoes later in the season.—E. W. CAKE.

CANADA

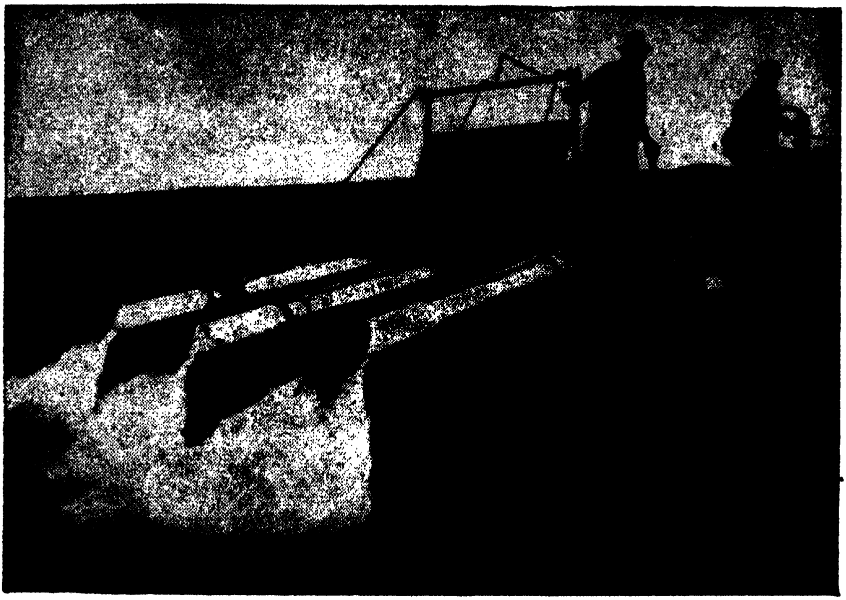
(Manitoba Section)

The Manitoba potato planting will be completed by 5th of June. The acreage is being increased by approximately 10 per cent over the 1947 plantings. The increase is mostly among the Russet, Green Mountain, Chippewa, Bliss Triumph and Warba varieties. The Irish Cobbler planting is considerably less over 1947 plantings. This is mostly due to depressed markets on cobblers because of excess hollow heart in the tubers. Our estimated total acreage will be 30,500.—H. WASYLYK.

(Ottawa Section)

At the recent sessions of the Provincial Legislature in Prince Edward Island, a bill requiring that all potato fields in the Province must be planted with certified seed only was approved. Actually this bill was passed a year ago, but it was brought up again for discussion and was endorsed. This is aimed at the control of bacterial ring rot, which is practically non-existent in this Province. The law also prohibits the importation into Prince Edward Island of potatoes from any source whatsoever without special authority from the Provincial Government.

Most of the certified seed in Canada has been sold, and in some areas a shortage has developed. The indications are that there will be an increased acreage of both seed and table stock in 1948.—J. W. SCANNELL.



(Province of Ontario)

Our supplies of potatoes are expected to be sufficient until the harvesting of our new crop which begins about the 28th of June. There has been some movement of Manitoba Commercial grade to Ontario points, and also arrivals of U. S. A. grade B have recently started in very limited amounts. Prices wholesale to retail Toronto market on the 11th of June are as follows: $4.00 per 75-pound bag; 15-pound paper 75 cents; 10-pound paper mostly 60 cents; Manitoba Commercial $2.65-$3.00, few at $3.25; California 100-pound size $3.00 to $3.65. Nearly all other markets higher than Toronto have prices firm. The shortage of quota money, which is also affecting citrus imports, has placed a very definite limitation upon the import of U. S. A. potatoes.

Some counties report a slight increase in acreage of early potatoes. Growing conditions to date in most sections have been very good. In Lambton County 25-30 per cent of the crop has been damaged by heavy rains after planting.

Planting of the late crop has been considerably earlier than usual, and plants in most fields are now (June 14th) showing above ground. With a favorable length of growing season, maturity should be well advanced by harvest time, thus favoring the general appearance and cooking quality of the 1948 crop. Most counties report that the acreage of the late crop will be about the same as last year, with increases of 10 per cent in the following areas—North Simcoe, Grenville, Ontario, Renfrew, Dundas, Slight decreases are reported from South Simcoe, Thundred Bay, Manitoulin, Lennox and Addington. The general condition of the crop is good. With increased amounts of machinery available there should be more satisfactory control of insects and diseases this year by spraying and dusting.

A warning service for blight is being organized by the officials from the Department of Agriculture. It is expected that there will be press and radio releases each Monday during the most dangerous part of the season. Any symptoms or outbreaks should be reported at once to your nearest agricultural representative or to the Botany Department, Ontario Agricultural College, Guelph.

The scab control program is underway with intensive studies being made on various angles. Growers have contributed more than $600.00 to date for the program in appreciation of the $10,000 appropriation and efforts expended by the Department.

500 Bushel Clubs have been organized in an increased number of counties this year, and a Championship Award is available on the basis of yield, marketable potatoes, exhibit and cooking quality.

There continues to be an increased interest in marketing, with the latest development at Kemptville, where a group of growers recently organized to undertake co-operative storage, grading and packaging.—R. E. GOODWIN.

(Prince Edward Island)

We are now planting potatoes in Prince Edward Island, and are far behind schedule because of the extremely wet weather. It is hoped, however, that with clearing weather, planting will be completed within the next two weeks.

Planting intentions on the part of the growers seem to be an increase in the Sebago variety of seed at the expense of Irish Cobblers. This has been due to the considerably smaller yield on the Irish Cobblers than from the Sebago variety, dunring the past few years. In general, the overall acreage will be similar to that of last year.

All potatoes planted on Prince Edward Island this year are required, by law, to be certified seed or better. Growers must, however, in order to qualify for seed certification, plant Foundation or Foundation A. This use of certified seed by all growers is a measure intended to eliminate the possibility of bacterial ring dot in the Province.

All of the 1947 crop has been marketed, with a total of more than 7½ million bushels being shipped from the Province, which includes both seed and tablestock.—E. D. REID.

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NEW BRUNSWICK, N. J.

USE OF CERTAIN NEW MATERIALS IN THE CONTROL OF POTATO INSECTS IN MICHIGAN[2]

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Michigan State College, East Lansing, Mich.

Field tests of insecticides and fungicides were made at the Lake City Experiment Station during 1947 using the Menominee variety. The 19 spray plots consisted of four rows 180 feet long, randomized and replicated three times. The 15 dust plots consisted of eight rows, 200 feet long. All the yields were taken from four harvestings of the two center rows forty feet long in each plot. The soil was of clay loam and of irregular fertility.

Materials were applied at ten-day intervals throughout the season beginning with the 15th of July and continuing to the 19th of September. All plots were irrigated five times during the season.

The insect populations were extremely low during 1947. All insect counts were made 2-4-6 and 8 days after each application until the 19th

[2]The writers are indebted to Mr. A. M. Berridge, Superintendent, Lake City Experiment Station, for providing facilities for conducting this project, and to Mr. Dale Bray, Graduate Assistant in Entomology, for his assistance in making insect counts.

[3]Published as Journal Series No. 930 (n. s.) at Michigan State College, East Lansing, Mich.

[1]Associate Professor of Entomology and Research Professor of Botany and Plant Pathology, respectively.

TABLE 1.—*Insect control on potato spray plots, Lake City Experiment Station—1947.*

Materials	Potato Leafhopper				Six-Spotted Leafhopper				Flea Beetles				Tarnished Plant Bugs				Bus. Per Acre U. S. No. 1
	*2	4	6	8	2	4	6	8	2	4	6	8	2	4	6	8	
1. B. L. 40—DDT—F-48 (1 Pt.-1½-4-100)	1	1	4	1	5	34	7	5	1	1	2	0	0	2	4	4	205.6
2. DDT Alone (1½-100)	0	2	0	4	1	3	1	3	1	0	0	1	0	0	2	1	177.1
3. Dithane—Zn—L.—DDT Emul. 2 qt-1-½-1 Pt.—100)	3	0	1	6	0	4	2	4	0	0	0	1	1	0	0	0	217.0
4. Zerlate—DDT (2-1½-100)	1	3	0	1	0	3	1	4	0	0	0	1	0	0	0	1	202.7
5. Dethyl—COCS (1 Pt.-3⅔-100)	2	0	4	8	0	0	3	5	1	0	0	1	2	1	0	6	204.4
6. Persisticide—Orthex—Orth. 53)1 Pt.-1 Pt.-4-100)	0	3	2	2	0	6	8	2	0	0	0	0	1	0	0	6	229.8
7. Genicop—Filmfast (4-½-100)	1	1	1	5	3	2	1	1	0	0	0	0	2	1	0	5	215.5
8. Phenotox—Copper A (1-5½-100)	4	3	1	4	0	3	2	2	0	0	1	2	2	2	4	0	214.2
9. Bord 8-4-100—DDT (8-4-1½-100)	1	2	2	3	2	8	1	5	0	0	0	0	0	2	5	3	192.2
10. Bord 8-4-100—BHC (8-4-3-100)	8	4	4	12	3	1	5	5	0	1	1	2	2	2	5	4	244.5
11. Check (No Treatment)	10	8	5	30	0	6	7	15	24	14	32	56	1	2	10	3	248.5
12. Z-78—DDT (2-1½-100)	2	0	3	4	7	3	3	2	0	0	0	2	2	1	0	5	237.8
13. Phygon—DDT (2-1½-100)	4	1	1	3	2	3	2	3	0	0	0	2	0	1	0	3	201.3
14. Parzate—DDT (2-1½-100)	2	2	2	6	3	2	2	5	0	0	0	1	1	0	1	2	233.4
15. (1) 3422—TBC (1.75-4-100)	0	3	2	5	1	3	2	4	0	0	0	0	1	0	0	1	208.1
16. 3422—TBC (2.5-4-100)	4	2	4	12	0	6	1	5	0	0	2	0	1	0	0	3	227.3
17. (2) 3422—TBC (1-4-100)	1	2	4	6	1	4	3	3	1	0	0	1	0	0	0	1	241.2
18. 3422—TBC (1.5-4-100)	2	0	6	11	1	4	2	7	0	0	1	0	0	0	0	1	208.2
19. Colloidal DDT—COCS	1	1	3	6	0	2	2	4	0	0	0	0	0	0	2	0	208.1

*Total counts made 2-4-6-8 days after application.
(1) 15 per cent Wettable 3422.
(2) 25 per cent Wettable 3422.

of September, when frost prevented further counts. Late blight was absent also and early blight on this variety showed a maximum of 15 per cent on the unsprayed checks.

Results of Insect Counts in Spray Plots

As previously stated, insect populations were extremely low and table 1 of the spray plots shows the combined counts made 2-4-6 and 8 days after applications throughout the season.

For potato leafhopper control, in general, DDT in either the 50 per cent wettable or 25 per cent in liquid form gave better results than did any of the other materials used, although this material varied greatly in its effect upon the six-spotted leafhopper.

Flea beetles were satisfactorily controlled by all of the materials used. Tarnished plant bugs were also effectively controlled by all insecticides used, with the exception of benzene hexachloride.

There is some indication (as shown in table 1) that where irrigation is used some spray materials seem to lose their efficiency after 6 to 8 days. This is shown by the increase in insect populations as given in table 1.

Results of Insect Counts in Dust Plots

Insect counts, as a whole, were more abundant in the dust plots than on the spray plots as shown in table 2.

Parathion (3422) 2 per cent + Tribasic copper gave the best control of potato leafhoppers whereas DDT 5 per cent + copper gave excellent control of the six-spotted leafhoppers. Somewhat variable results were obtained with all materials in the control of flea beetles and tarnished plant bugs, but DDT gave as good if not better control than did any of the other materials used.

Here again, as shown in table 2, there was a slight increase in insect populations after six days.

Summary

In the spraying and dusting experiments at the Lake City Experiment Station during 1947 insect infestation was not a serious problem. Most consistent control of potato insects in general was accomplished by applications of DDT in either sprays or dusts. Of the new materials used, Parathion 3422 as a dust was the most promising particularly in the control of the potato leafhoppers, whereas applications of 5 per cent DDT gave almost complete control of the six-spotted leafhoppers, flea beetles, and tarnished plant bugs. Benzene hexachloride, as a dust, ranked with DDT in the control of tarnished plant bugs and flea beetles. In the

TABLE 2.—*Insect control on potato dust plots, Lake City Experiment Station*—1947.

Materials[1]	Potato Leafhopper				Six-Spotted Leafhopper				Flea Beetles				Tarnished Plant Bugs				Bus. Per Acre U. S. No. 1
	*2	4	6	8	2	4	6	8	2	4	6	8	2	4	6	8	
1. TBC+DDT 3%+BHC 0.5%	1	3	9	10	1	8	9	6	0	0	0	3	0	0	2	0	176.0
2. TBC+DDT 3%	0	1	7	7	1	4	8	7	0	0	1	7	1	0	0	2	215.3
3. DDT 3%	1	1	5	18	3	3	8	6	0	0	2	5	2	0	1	0	221.1
4. Y. Cupro+DDT 0.5% Impreg.	1	6	6	16	5	4	9	9	3	3	11	50	0	0	1	3	286.4
5. Y. Cupro+DDT 1%+Pyr. (2) 0.06%	1	2	5	9	2	4	3	3	2	2	0	6	2	2	1	3	278.8
6. TBC+Nic. Conc. 2% DDT ¾%	5	1	5	9	1	2	2	3	1	0	4	9	0	1	2	0	288.4
7. TBC+DDT 5%	0	1	3	8	0	0	2	0	0	0	2	5	0	0	1	0	245.4
8. No Treatment	15	15	14	17	7	2	5	8	4	12	12	72	2	4	1	5	361.7
9. Copper-Lime+DDT 9%	2	3	5	7	3	0	1	1	0	1	5	10	2	2	0	9	304.0
10. TBC+3422 1%	1	7	11	16	1	1	0	4	2	2	9	11	1	2	0	4	357.9
11. TBC+3422 2%	1	0	3	5	0	2	1	5	2	1	1	6	2	2	1	1	324.2
12. TBC Cupro+DDT 1%+Py. (2) 0.12%	3	3	15	11	1	6	4	7	0	5	5	6	0	1	1	3	255.4
13. Z-78 6%+DDT 3%	0	2	3	9	0	2	4	7	0	0	2	3	0	0	0	2	276.9
14. Bordow+BHC 1%	1	6	12	21	0	6	9	10	1	3	2	3	0	0	0	1	232.4
15. Basicop+DDT 5%	3	0	5	16	1	2	6	5	0	0	0	1	2	0	0	1	242.4

*Total counts made 2-4-6-8 days after application.
(1) All Copper Materials at 7 per cent metallic.
(2) Pyr. Pyrethrins.

control of leafhoppers, however, benzene hexachloride in dust or spray combinations was not as effective as DDT. No late blight was present. There were no significant differences between materials in the control of early blight, because of the early killing frost.

As indicated in tables 1 and 2 where irrigation was used, an increase of insect populations was observed after six days in both the spray and dust plots. Insect counts were not correlated with yields of potatoes and the high yields of the untreated check plots can be attributed in great part to lack of serious insect infestations and diseases and also to the fact that the spraying and dusting equipment was not drawn through the rows where yields were taken.

FOREIGN POTATO INTRODUCTIONS

F. J. STEVENSON[1]

Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture, Beltsville, Md.

The introduction of new varieties or species of potatoes may not appear to be a plant-breeding procedure yet it is fundamental to a well-rounded breeding program. It is improbable that varieties will be found in foreign countries, with the possible exception of the Dominion of Canada, that are adapted to any of the potato-growing regions of the United States; but even if the new introductions cannot compete with the standard varieties they may carry genes for certain characters that will make them extremely valuable from the breeding standpoint.

The total number of accessions in the record books of the Potato Project exceeds 25,000. These include commercial varieties from our own and foreign countries, seedling varieties, and species. There are many duplicates, but several thousand different sorts have been collected during the past 35 years. Many of these were discarded either because they were thought to be of no value or because they were infected with virus diseases. In a number of instances the introductions showed disease symptoms when they were first grown in the field, and many others soon acquired various diseases and had to be discarded.

Since 1930 the Division of Plant Exploration and Introduction has brought into this country more than 700 varieties and species of potatoes. An expedition to Mexico in 1930, conducted by Paul Russell of that

division in cooperation with Donald Reddick of Cornell University, brought back about 68 lots of tubers and 3 lots of seed. A number of the lots were *Solanum demissum;* most of the others were *Solanum tuberosum.* These were taken to Cornell to be used by Dr. Reddick in his potato-breeding work, and a sample of each was turned over to the Division of Fruit and Vegetable Crops and Diseases. In 1932 another expedition was sent to South America. This expedition was led by C. O. Erlanson, representing the Division of Plant Exploration and Introduction, and H. G. MacMillan, representing the Division of Fruit and Vegetable Crops and Diseases. Of the collections sent in, 344 were given accession numbers. These were collected on the Island of Chiloe, from other parts of Chile, and in Peru and Bolivia. Those from Chile and Peru were sprouted in the quarantine greenhouse at Beltsville, Maryland, and the sprouts were shipped to Presque Isle, Maine. The collection from Bolivia was received too late to plant in 1932 but was planted in 1933.

In the 1932 report to all cooperators of the National Potato-Breeding Program it was announced that as soon as material of these introductions was available it would be distributed to the interested cooperating experiment stations to be tested for disease resistance and other desirable characters. In 1934 seed stock was requested and sent to F. A. Krantz, University Farm, St. Paul, Minnesota; to Donald Reddick, Cornell University, Ithaca, New York; and to J. H. Beaumont, University of Maryland, College Park, Maryland. None of the other cooperators requested any of the collection.

Cytological studies by F. J. Stevenson and C. F. Clark showed that the varieties from Chile belonged in the 48-chromosome group, but a number of those from Bolivia and Peru had 24 chromosomes as the somatic number. Tests and observations for disease resistance and other characters at Presque Isle, Maine, and Oakland, Maryland, and on what is now the Plant Industry Station, Beltsville, Maryland, did not reveal any outstanding traits that were not available in better-adapted varieties and seedlings.

The introductions that have contributed the most to the potato-breeding program are not the miscellaneous collections that have been made, but those that have been brought in for specific purposes. Dr. Reddick went to Mexico to get varieties of *Solanum demissum* some of which were considered immune to late blight. He has made good use of these in his breeding work, and although the first group of varieties he distributed to growers are not immune in the field, they are very

highly resistant and may be valuable to growers until immune varieties can be developed.

The blight-resistance program of the Federal workers was greatly advanced by the introduction of true seed of 10 crosses received in 1932 from K. O. Müller, Berlin-Dahlem, Germany. The seedlings were grown and sprayed with blight spores in the field at Presque Isle, Maine. Some of the seedlings were apparently immune to the physiologic races prevalent in Maine; others were very susceptible. None of them was desirable from the commercial standpoint, but a series of crosses was made between some of the best of them and selected seedlings and varieties. A few selections from this series showed the same reaction to late blight as that of the German parent, but showed a substantial improvement in yield and quality. The best of these were selected and crosses made to various varieties and seedlings. From this second series we have a number of selections that will compete with the standard varieties in yield and quality and that are highly resistant to blight in both vines and tubers. They are not immune, but in the tests in Maine they do not develop blight until they have made their crop and are approaching maturity, when some of the lower leaves will show small lesions. In contrast to these, the Green Mountain similarly inoculated is killed 30 to 40 days earlier, when its tubers are not much larger than a walnut.

The scab-resistance program in the United States was greatly boosted by the introduction of the varieties Arnica, Hindenburg, Richter's Jabel, and Hindenburg x Centifolia No. 9 and No. 15 These were received in 1934 from A. P. Lunden, Aas, Norway. All the scab-resistant varieties that have been distributed to growers, such as Menominee, Ontario, Seneca, and Cayuga, and a number that are now under test, inherited their resistance from one or the other of these varieties. Ostragis, introduced in 1935, and Ackersegen have also contributed to this part of the breeding program.

In 1935, the varieties Albion, Bevelander, Friso, Noordeling, Triumf, and West Brabander were introduced from the Institute for Plant Breeding, Wageningen, Holland, because they had shown resistance to leaf roll. Some of our most resistant lines inherited their reaction from Triumph. Crosses with Albion failed to give worth-while resistance. Friso was found to be resistant to ring rot. Also in 1935, 97 varieties were sent to us by the Institute of Plant Industry, Leningrad, Union of Soviet Socialist Republics. These were grown in Maine and observations were made of their various characters. They were very poor yielders.

In 1936, five varieties resistant to leaf roll were introduced from Scotland. These were Cardinal, Chance, Kepplestone Kidney, and Shamrock. A number of selections from a cross of Kepplestone Kidney x Earlaine showed resistance to leaf roll in the tests made by Donald Folsom at Highmoor Farm, Maine.

There is a demand in this country for varieties of potatoes with high dry-matter content. In fact, this character is closely associated with what is called good cooking quality. In an effort to increase, if possible, the dry-matter content, a number of so-called high starch producers were brought in from Germany and Holland. Among these were Ackersegen, Ostbote, and Starkeragis, which have been used as parents in crosses. In tests in Maine these have shown only a slightly higher dry-matter content than that of some of our best varieties and seedlings, and so far the progenies have been disappointing in yield and market qualities. The variety Calrose is an exception to this. It is a cross between Ackersegen and Katahdin. It was selected in Maine because of its resistance to late blight and sent to California where it proved to be a very high yielder if given plenty of irrigation water. It requires a long growing season, and has slightly yellow flesh. Another group of high starch producers has been introduced from Holland.

In 1939 another group of species and varieties was received from the Institute of Plant Industry, Leningrad, but aside from the fact that a few crosses were made with these they did not contribute anything to the potato-breeding work.

Only a few introductions were made during the war years, but in 1944 we received from D. F. McLeod of the Agricultural Experiment Station, Fredericton, New Brunswick, Canada, a large number of species and varieties from the British Empire Collection. Many of these were marked as diseased by Dr. McLeod, and still others were found to be infected with viruses. Some crosses were made, and seed was collected from a number of the self-fertile lots, but no serious effort has been made to maintain this collection.

The British have set up an institute for the purpose of collecting and maintaining potato materials from all parts of the world. One of their present objectives is to free the British Empire Collection from viruses and other diseases. If breeders are interested in definite species they can no doubt secure them from England or the Dominion of Canada through the Division of Plant Exploration and Introduction, Plant Industry Station, Beltsville, Maryland.

The latest introductions are 25 varieties released from quarantine on the 21st of November, 1947. One was sent to us by Carl Ross,

Bipartite Control Office, Food and Agriculture Group, Germany. It is a recently developed variety, claimed to be resistant to virus diseases; it is not stated which viruses. Three are selections from crosses made in Australia. Katahdin is the male parent of two of these, and U. S. D. A. Seedling 336-144 is the pollen parent of the other. The varieties Ulster Cromlech and Ulster Ensign are from Ireland. Nineteen varieties were obtained from the Netherlands.

A list of the countries from which we have received potato materials since 1930 would include Argentina, Australia, Bolivia, Canada, Chile, Cuba, Germany, Holland, Ireland, Java, Norway, Mexico, Peru, Philippine Islands, Russia, Scotland, Tasmania, and Uruguay.

The introduction of varieties and species of potatoes is not a one-way proposition. Since 1930 we have sent to foreign countries many varieties and seedlings. The requests have been plentiful throughout this period, but have increased since the war. Since 1943 we have sent material to Australia, Argentina, Belgium, Brazil, Canada, Chile, Colombia, China, Costa Rica, Cuba, England, Egypt, France, Guatemala, Haiti, Holland, Honduras, Iceland, India, Ireland, Italy, Mexico, New Zealand, Norway, Palestine, Poland, Portugal, Russia, South Africa, Spain, Sweden, Uruguay, Venezuela, and Yugoslavia.

Among the seedlings that have been sent to foreign countries from time to time, the U. S. D. A. Seedling 41914 has been selected and named Canus by the Agricultural Experiment Station, LaCombe, Alberta, Canada. The Australians are asking that U. S. D. A. Seedling 336-144 be named so that it can be certified and distributed to their growers. One of the seedlings from an unselected progeny has been named in Argentina.

In order to keep the cooperators in the National Potato-Breeding Program informed about the various introductions, we included in the earlier yearly reports references and lists of these foreign varieties. However, in the recent reports the lists have been omitted, but those engaged in potato breeding know that we maintain a number of stocks for use in the program, and we have always filled requests insofar as our material would permit. The severe leaf roll epidemic of 1938 eliminated a relatively large number of our breeding stocks in Maine, but we still have in our variety collection about 70 old and new American varieties and 29 European varieties. In addition to this we have a large number of seedling varieties that carry genes that are considered important in our present program.

A list of available genetic characters would include the following:

(1) wide adaptation; (2) variation in time of maturity from very

early to very late; (3) desirable shapes of tubers; (4) high yielding ability; (5) shallow eyes; (6) high dry-matter content; (7) field immunity from mild mosaic (virus A); (8) immunity from latent mosaic (virus X); (9) resistance to veinbanding mosaic (virus Y); (10) resistance in vines to leaf roll virus; (11) resistance in tubers to net necrosis caused by leaf roll virus; (12) resistance to yellow dwarf; (13) high degree of resistance to late blight in both vines and tubers; (14) resistance to scab; (15) immunity from potato wart; (16) resistance to ring rot; (17) to brown rot; (18) to blackleg; (19) to leafhopper injury; (20) to flea beetle injury; (21) to aphid injury; and (22) resistance to psyllid yellows.

The present official procedure in getting foreign introductions into this country is to make the request to the Division of Plant Exploration and Introduction, Bureau of Plant Industry, Soils, and Agricultural Engineering, United States Department of Agriculture. When tuber stock is brought in it is carefully inspected by the Division of Entomology and Plant Quarantine. If, after cutting the tubers, no visible disease is apparent the seed stock is planted in a quarantine greenhouse at the Plant Introduction Gardens, Glenn Dale, Maryland. The plants are examined from time to time for disease symptoms. If no disease is apparent they are grown to maturity and harvested. Part of the tubers are released to the person who requested the introduction and the remainder to the Potato Project of the Division of Fruit and Vegetable Crops and Diseases. These regulations may seem drastic to some people but the author is in favor of a strict quarantine after having seen some of the potato samples that have come from foreign countries. For example, a number of years ago an inspector found potato wart on some samples that had been collected in South America. Those on which the disease was found were immediately consigned to the incinerator; the others were grown in the quarantine greenhouse, since no one could be certain that all the tubers infected with wart had been picked out, and we were unwilling to take them to the field for increase until the plants produced from the foreign tubers could be carefully inspected for disease symptoms.

At present there is much talk about collecting and preserving genetic material for future breeding work. This is a worth-while project and should be undertaken without delay while there is still a wealth of material in South America and other parts of the world. However, if the greatest use is to be made of the introductions, a special organization should be responsible for their maintenance and study. The work should not be left to the plant breeder. He will maintain the

relatively few lines that are necessary to meet the objectives of his program and will discard whatever seems to be of no use to him or his associates, at present, or in the near future.

The new organization should be provided with facilities and personnel to:

1. Maintain the stocks as free from disease as possible, by growing them in isolation, by tuber indexing, by roguing, and by early harvesting.
2. Ascertain from others or from personally conducted tests the disease reactions of the various lines.
3. Study the plant characters and write complete descriptions of the lines that are to be maintained.
4. Study the lines cytologically.
5. Study their flowering habits and their pollen production.
6. Study the crossability of the various species.
7. Self the self-fertile varieties and species and keep a supply of seed under optimum conditions for maintaining its viability.
8. Make germination tests of seed from time to time and renew the supply of the lots that show reduced viability.
9. Publish lists of varieties and seedlings with their important class characters.
10. Distribute tubers and seed to those requesting it.

Summary

Thousands of varieties and seedlings of various species of potatoes have been introduced to this country during the past 35 years. Since 1930, two expeditions under the direction of the Division of Plant Exploration and Introduction have explored parts of Mexico and South America. Many smaller lots have been introduced from time to time. These included seed or tubers of the most promising sorts reported in the literature, seed and tuber stock of varieties and species carrying genes for resistance to late blight, varieties resistant to scab and to leaf roll, and varieties reported to be high in dry-matter content. These have contributed much to the plant-breeding program. They have been introduced from a relatively large number of countries. Since 1943 the United States Department of Agriculture has sent potato stocks to 34 foreign countries.

A list of available genetic characters is given. The present official procedure in getting foreign introductions into this country is described.

Recommendations are made for the organization of an institute whose sole objectives would be the introduction of potato material, its maintenance, and certain studies relating to its possible usefulness.

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[1]Principal Geneticist.

OBSERVATIONS OF APHIDS ON POTATOES IN NORTHERN WISCONSIN, 1947

C. M. Voss and Floyd Andre

Wisconsin Agricultural Experiment Station, Madison, Wis.

The potato aphid, *Macrosiphum solanifolii* (Ashm.), and the green peach aphid, *Myzus persicae* (Sulz.), are important pests of potatoes in the seed-producing areas of northern Wisconsin. Since both species are vectors of plant disease, the desirability of keeping them from building up in epidemic proportions on potatoes is particularly significant. Studies on their biology and control have been underway for several years.

Field Observations in 1947

Due to the wet season in the Rhinelander area, potatoes were planted somewhat later in 1947 than usual. The first potato plants appeared the second week of June. In the meantime the potato aphid was observed to be multiplying on several of its weed hosts in the area, especially on campion or cockle weed. From the middle of June to the first week in August steady flights of these aphids occurred and representative samples were collected in 7 wind screen traps placed at various locations throughout the area. Apparently, the earlier flights were from host plants such as campion since a high percentage of winged forms were observed developing on them.

Potatoes were not infested with winged aphids until several days after plant emergence. Our counts indicated that in some fields all plants were infested during the first month of plant growth. Throughout July and early August, regardless of the spray program, all leaf counts indicated relatively high numbers of aphids on several fields of early potatoes in the area. Parasites and predators were also numerous but the aphid population did not decline until after two weeks of hot, dry weather in early August when the temperatures reached 99° F. The remaining nucleus of aphids was maintained on the lower leaves of the plant and in early September increased to high numbers in all fields observed, including later plantings of potatoes.

Data were taken in eleven fields treated with DDT wettable powder in Oneida and Vilas counties to observe the aphid population trend. These counts were taken during July, August, and September. The relatively high numbers of potato aphids in relation to other insects are shown in table 1. Early in August aphids decreased as a result of high temperatures. The number of aphids built up again in September when the weather became cooler.

TABLE 1.—*Insect counts taken from sweeps of eleven potato fields treated with DDT wettable powder near Rhinelander, Wisconsin,* 1947.

Month	Numbers per 100 Sweeps*				
	Potato Flea Beetle	Potato Leafhopper	Six-spotted Leafhopper	Tarnished Plant Bug	Potato Aphid
July	17.6	10.9	6.3	11.0	81.0
August	129.0	13.4	24.0	7.9	48.5
September	16.4	9.6	6.4	8.4	131.5

*Average based upon a total of 6,580 sweeps taken on random dates during this three-month period.

The total aphids counted during July and August from sweeps of two fields sprayed with calcium arsenate amounted to nearly the same number as those from the DDT-sprayed fields.

These counts, although relative, indicate that the DDT wettable powder as used in the growers' spray program was not controlling the plant lice. Even though not present in epidemic numbers this summer, the aphids were numerous enough to prove serious from the viewpoint of the dissemination of virus diseases.

Control Tests in the Field and Laboratory

Of several insecticides tested against the aphids on potatoes during the summer of 1946, a new material, hexaethyl tetraphosphate, proved particularly effective.

Laboratory tests were conducted during the fall and winter of 1946-1947 to determine the relative toxicity of different dilutions of this and tetraethyl pyrophosphate to the potato aphid. It was found that hexaethyl tetraphosphate at 1-3200 dilution (¼ pint per 100 gallons) gave good control when sprayed directly on the aphids. Tetraethyl pyrophosphate proved more effective since good kills were obtained at dilutions ranging to 1-6400 in this experiment.

Other tests were conducted in the greenhouse to compare wettable DDT powder with the oil-emulsion form. The results indicate a greater kill from the DDT-oil emulsion both as a residual poison and as a direct spray on the aphid.

These materials were compared in various concentrations in the field during the summer of 1947. DDT-oil emulsion was applied on four fields throughout the season alongside an equivalent amount of DDT in 50 per cent wettable powder form. Counts taken after each spray application showed about twice as many aphids on potatoes treated with the DDT wettable powder. Tests with single applications of insecticides were conducted on various fields found infested with potato aphids. In table 2 are shown the results obtained from three fields treated on the 25th and the 28th of July, 1947. The materials were applied at the rate of 125 gallons per acre with an 8-row 400-gallon power sprayer operating at 400 pounds pressure. The counts from fields A, B, and C indicate that the DDT-oil emulsion used at the higher concentration gave better control. The relatively low kill of aphids in fields A and B indicates that TEP is not compatible with Bordeaux mixture. Best control was obtained with this material when used with tribasic copper sulphate fungicide in field C. It should be noted that DDT in combination with tribasic copper sulphate does not show so wide a range of difference between the wet-

TABLE 2.—*Number of potato aphids collected from sweeps in three fields treated with five formulations of insecticide.*

Material (Amounts per 100 gallons)	Field A—Triumph Potatoes Bordeaux, 10-5-100				Field B—Chippewa Potatoes Bordeaux, 10-5-100			Field C—Chippewa Potatoes Tribasic Copper Sulphate, 4.5 lbs.-100		
	24 hr.[1]	3-day	5-day	Total	3-day	5-day	Total	3-day	5-day	Total
1 lb. 50% wettable DDT	135	189	174	498	66	89	155	63	111	174
2 lb. 50% wettable DDT	194	171	103	468	29	123	152	51	55	106
1 qt. DDT oil[2]	80	98	66	244	28	22	50	53	73	126
2 qt. DDT oil	24	33	30	87	10	10	20	28	39	67
¼ pint 100% tetraethyl pyrophosphate[3]	119	97	110	326	49	52	101	5	9	14

[1]Represents a total of 32 sweeps or 16 sweeps from each of the treated field.
[2]One quart contains ½ pound actual DDT. Supplied by the Shell Oil Company.
[3]Supplied by the Victor Chemical Company.

TABLE 3.—*Comparative numbers of aphids taken in sweeps and leaf counts from a field of Cobbler potatoes treated with eight formulations of insecticides.*

Materials (All contained 5 pounds Tribasic copper sulphate except where designated)	Numbers from Lower Leaves[3]			Totals from Top and Middle Leaves[4]	
	Potato Aphid	Green Peach Aphid	Total	All Potato Aphids	Total Aphids from Sweeps[5]
½ pint HET[1]—no fungicide	40	2	42	8	11
½ pint HET	43	19	62	18	27
1 pint HET	25	0	25	7	13
¼ pint tetraethyl pyrobase—no fungicide[2]	73	21	94	23	24
¼ pint tetraethyl pyrobase	71	6	77	33	41
½ pint tetraethyl pyrobase	69	19	88	23	23
2 quarts DDT-oil emulsion	25	1	26	10	10
3 quarts DDT-oil emulsion	17	0	17	13	10
Check—no treatment	107	11	118	99	63

[1]Hexaethyl tetraphosphate (100 per cent). Supplied by Victor Chemical Company.
[2]Tetraethyl pyrobase containing 40 per cent tetraethyl pyrophosphate. Supplied by the Victor Chemical Company.
[3]Represents the numbers from 20 lower leaves counted per material 48 hours after treatment.
[4]Represents the total number of aphids counted from 40 leaves per material or 10 random leaves from each end of the two replicates.
[5]Counts from 64 sweeps or 32 from each replicate 48 hours after treatment.

table and oil emulsion formulations as it does when used with Bordeaux fungicide. Perhaps the masking effect of Bordeaux is more pronounced in reducing the effectiveness of DDT when in the wettable powder form than when in an oil emulsion.

Regarding the other insects on potatoes the DDT-oil emulsion gave control similar to that of the DDT wettable powder.

Early in September a test was applied to a field of Cobbler potatoes infested with the potato aphid and the green peach aphid. The materials were applied at the rate of 125 gallons per acre to two replicates of eight rows each randomized through the field. Forty-eight hours after treatment, leaf counts of 15 random leaves were taken from each end of the two replicates giving a total of 60 leaves examined per material. Sweeps with an insect net were also made and the aphid numbers recorded in table 3.

These results emphasize the problem of obtaining a satisfactory kill of the aphids on the lower leaves. The counts from the lower leaves, although less than the check, do not, in general, indicate a good control. For the purpose of determining the effectiveness of the several materials in this test the comparison is based on sweeps and leaf counts from the upper and middle portion of the plants. The same relationship between the various sprays appears to exist in both the counts and the sweeps. The hexaethly tetraphosphate and pyrobase materials gave the best control when not in combination with the tribasic copper sulphate. The addition of this fungicide appeared to decrease the toxicity of these two insecticides. The DDT-oil emulsions ranked close to the hexaethyl tetraphosphate in control.

From a practical viewpoint there are several considerations that must be kept in mind with reference to the polyphosphates. Both field and laboratory tests in Wisconsin indicate that these materials are effective for the control of the potato and green peach aphid. Their compatibility with fungicides and insecticides needs careful study. The proper timing of sprays, correct formulations, and immediate application following the preparation of the spray mixtures are important.

Results from field trials during 1947 indicate that even though high aphid kills are obtained with sprays applied early in the season, some aphids remain. From these and migrating winged forms large numbers develop if control practices are not continued later in the season. In some instances it may be necessary to incorporate this insecticide in several sprays. This would increase spraying expense since DDT would also be essential for the control of other pests.

It might be more practical for the potato grower to use DDT-oil

emulsion with the thought in mind that this material may satisfactorily control aphids as well as the other insects present. Preliminary results indicate that it is compatible with most fungicides; that the toxicity does not decrease shortly after mixing and applying but leaves a poisonous residue on the leaf surface; that it controls the aphids on potatoes better than wettable DDT powder; and that it is equivalent to wettable DDT for the control of other insects such as flea beetles, leafhoppers, and plant bugs.

SUMMER MEETING OF THE POTATO ASSOCIATION OF AMERICA

The Potato Association of America will hold a summer meeting jointly with the Plant Breeding, Seed Certification and Plant Pathology Groups at Presque Isle, Maine, August 19 and 20, 1948.

You will note from the following tentative program that many timely and important topics will be discussed.

GENERAL MEETING

August 19, 1948

9 A. M. New Potato Storage House, Aroostook Farm
Greeting Dr. Fred Griffee, Director, Maine Agricultural Experiment Station
Purpose of Conference—E. L. Newdick, President Potato Association of America

10 A. M. Study of Variety and Disease Plantings
1. Breeders—Robert Akeley—Leader
2. Pathologists and Certification Officials—Dr. Reiner Bonde—Leader

12:30 P. M. Lunch

2 P. M. Study of Variety and Disease Plantings, with leaders
Aroostook Farm

6:30 P. M. Dinner (Guests of Maine Certified Seed Growers)

7:30 P. M. Evening Conference
Sound Film, "Certified Seed in Maine"
Speakers: A. K. Gardner, Commissioner of Agriculture, State of Maine
William H. Martin, Editor, American Potato Journal

August 20, 1948

9:00 A. M. Study of Variety, Disease and Foundation Plantings

12:30 P. M. Lunch

1:30 P. M. Visit to Potato Storages, Alcohol Plant, Starch Factory and Seed Fields in Canada, for those interested
Further study of Variety and Disease Plots, for those desiring to continue inspection

This is your invitation to inspect, with leading specialists, the many new potato seedlings and varieties as well as most of the known potato diseases. Seed Certification personnel, Potato Breeders and Plant Pathologists are especially invited to attend.

Accommodations will be taxed to capacity, so make your reservation early.

WRITE TO VERNE BEVERLY, COUNTY AGRICULTURAL AGENT, PRESQUE ISLE, MAINE, FOR RESERVATIONS.

SECTIONAL NOTES

MAINE

E. L. Newdick, President of the Potato Association of America is making every effort for the members of the Association to see the Aroostook potato industry at its best when they attend the field meeting on the 19th and 20th of August. The program is planned so that those who attend can get the most from the conference. A swing through the county is planned for those who would like to see the industry in all its phases.

The season is somewhat backward. Although our planting operations were finished at an early date, rains slowed things up, and the relatively cool weather during June has set the crop back. Spraying and roguing are a couple of weeks behind. The stand of potatoes is rather poor, due to the fact that the low areas in many of the early-planted fields have been drowned out. Conditions are somewhat worse than usual but despite these conditions every one is anticipating a good crop.

A survey by the P. and M. A. indicates that 81 per cent of the potato acreage in 1947 was planted from certified seed plot stock. In view of the Blue Tag Certified Seed campaign, sponsored by all agencies this year, indications are that about 90 per cent of the acreage was planted with certified seed in 1948. Reports reaching us from other states show that Maine seed has the lowest virus content in history. This proves that the Florida tests last winter were very accurate.

E. L. Newdick reports that the following certified seed entries have been made: Katahdin, 38,728; Chippewa, 11,782; Green Mountains, 8,556; Cobblers, 7,027; Sebagos, 2,878; Mohawk, 388; Russet, 213; Houma, 159; Bliss Triumph, 136; Sequoia, 106; Pontiac, 56; Warba, 19; Teton, 11; Pawnee, 6; Ontario, 4; Kennebec, 1½. It is apparent that the figures for the Foundation Seed Farm owned by the Maine State Seed Potato Board are not included in this acreage for they would have some Kennebecs on the farm which they purchased for the purpose of multiplying disease-free stock.

The industry has followed Congressional action very closely and farmers believe that the long term agricultural program as it relates to potatoes means stabilization for the potato industry.—(VERNE C. BEVERLY.)

MICHIGAN

Michigan's acreage of table stock this year is somewhat lower than last year. A greater acreage of the table stock has been planted with certified seed this year than in previous years.

The certified seed acreage listing is not yet completed. However, indications are for about the same seed acreage as last year.

Our planting season varied from a week to ten days earlier than normal, and our plants are off to a very good start. The weather has been very favorable to date with sufficient rains, except in a few areas. Growers, who irrigate, have not had to apply water as yet.

Indications are that several of our Michigan people plan to attend the summer meeting of the Potato Association of America at Presque Isle, Maine, on the 19th and 20th of August.—(H. A. REILLEY.)

NEW JERSEY

Irish Cobblers are now being harvested throughout the state. The yields being obtained are more or less variable because of the heavy leaching of fertilizer in some of the lighter soils, and perfectly normal growth in other fields. The quality is good and very little rot is present. Late blight has not progressed very much not only because of thorough spraying, but also because we have experienced much better weather conditions.

The practice of digging immature potatoes, employed by too many growers, is being strongly opposed not only because of the effect of "green" potatoes on the market but because the increase in yield obtained,—providing the potatoes are allowed to mature,—will usually far exceed the slightly higher price received for the early harvested potatoes. In a survey made with the Katahdin variety from 1944 through 1947, weekly harvestings from three farms indicated that on the average potato yields would increase 23 per cent or 41 sacks of U. S. One's between the time 50 per cent of the leaves were dead and maturity (this includes one field which was harvested when only 72 per cent of the leaves were dead.) The yield increased 48 per cent or 93 sacks of U. S. One's in one field in 1947, and in another field in 1946 the yield increased 82 sacks or 57 per cent after 50 per cent of the leaves were dead. In years of relatively high rainfall and normal temperatures during July and August, a much greater yield increase would naturally be expected than in years when rainfall is deficient and temperatures are very high during these months.—(J. C. CAMPBELL.)

NEW YORK

Because of a very wet spring, planting was continued until after the 1st of July; two weeks later than usual.

Our early-planted potatoes have shown a vigorous growth, and a good start and promise of a good crop. The vine growth is heavier than in some sections south of us which were planted a month earlier.

As previously announced, the Empire State Potato Club will hold its Summer Field Day on the 12th of August at the Hopkins Farms at Pittsford. When you scan the list of entries it is easy to visualize that potato growing is rapidly becoming mechanized. More new machinery is listed than ever before. Many of these new models have not as yet been catalogued. The Field Day, with its demonstrations, offers an opportunity to see the latest machines a year in advance of production.

Besides our own Field Day many growers are planning tours to other sections during the summer to improve their own methods and appreciate the problems of other potato growers.

New York growers are carefully watching the developments of the Marketing order in Virginia and North Carolina in an effort to figure out what might happen under local application. No new efforts are being made, however, to promote Marketing Agreements as yet—(H. J. Evans.)

Oregon

The potato fields in Klamath Basin are looking better on the average than ever before. The basin has never planted better seed. Our stands are very good, and there has been very little seed piece rot. Our plants are also making a very good growth. There has been no frost injury to date,—the 4th of July.

The acreage totals vary somewhere between 17 and 18,000. If we have a normal season from now on, we should have a very nice crop.

Considerable acreage is being dusted or sprayed with DDT for aphid control.

The Marketig Agreement Control Committee members and alternates held their Organization Meeting here on the 13th of July.—(Walt Jendrzejewski.)

South Carolina

Our 1948 potato crop is now history that is not very pleasant reading. Approximately one-third of the acreage was abandoned when excessive rains rotted the seed. The yields on the remainder varied from good to poor. The tuber size was smaller than normal. However, the quality in the early crop was better than anticipated. The quality of the late harvestings was very disappointing. Late blight and southern bacterial wilt took heavy tolls in many fields.

Because of the flooded markets a large portion of the crop was moved through the government purhase program. No potatoes had to be dumped as in former years.

The washing program, started on a large scale last year, paid off again. At times when there was no sale on the unwashed potatoes the

washed product was in demand on a cash F.O.B. basis and at a premium above suport price. One interesting feature of the purchase program was that growers would sell to it rather than to commercial buyers because the latter demanded safe delivery on terminal markets whereas the other was on a F.O.B. basis. The final result was that orders on unwashed potatoes frequently went begging.—(W. C. BARNES.)

SOUTH DAKOTA

The potatoes in South Dakota look excellent at the present time. Many of the fields have been laid by and have been inspected for the first time. More than 6,700 acres have been entered for certification and there are still a few late applications to be sent in.

Dr. C. E. Rosenquist from the Botany Department of Nebraska University, is assisting with the field inspection this summer.

The committee members were nominated for the committee to administer the potato marketing agreement program and we expect to receive an announcement of their selection very soon, from Washington. The area which will be covered by the marketing agreement includes six counties in the northeastern part of South Dakota where the bulk of the commercial potato acreage is planted.

Our growers expect to start digging early this year—probably between the 10th and 15th of August. The tubers in the early-planted fields are now large enough to be used as new potatoes.—(JOHN NOONAN.)

WASHINGTON

Our potatoes in the State of Washington are making a very rank growth, although they are about three weeks later than they should be in a normal year. So far growers are finding that tuber production is slow but this is expected to improve since we have had warm sunny weather the last two weeks. The crop is quite free from disease up to the present time despite the fact that we have had an unusually wet spring. Traces of early blight are showing in most of the commercial fields on the bottom leaves but no damage is being done by this fungus. So far no late blight has appeared and only an occasional hill shows black leg.

Virus diseases are less prevalent than usual in most of the fields at the Moses Lake area. We have a new trouble here which has been designated by some as late-breaking leaf roll. It resembles quite markedly what eastern growers know as purple top. In varieties which do not have the coloring matter, the trouble has a yellowish cast rather than a purple one. Fields which show no disease at all until after the flower buds appear may be one hundred per cent infected with this trouble

before being harvested. So far as we know, the yield is not reduced appreciably and no net necrosis has appeared.—(M. R. HARRIS.)

PROVINCE OF ONTARIO

The condition of our potato crop is reported as "good" to "excellent" in practically all counties and districts throughout the Province. Flea beetles have been abundant, but good control has been experienced where DDT has been used according to recommendations either in spray or dust forms. Leafhoppers are beginning to attack in some areas, and growers have been warned to be on guard against these destructive insects. It is expected that an increased number of growers will properly apply copper fungicides this year to control blight.

New potatoes are now being marketed in volume with excellent quality, available to consumers. Commencing the 1st of July, control of potato sales grown in the counties of Essex and Kent, and in the township of Adleborough in Elgin was vested in the Southwestern Ontario New Potato Marketing Board under the terms of the Farm Products Control Act. In essence, the scheme forces the sale of potatoes in the prescribed area through the designated agencies, and came into effect as the result of a recent vote of potato growers in the area mentioned. Prices quoted on the Toronto market (July 8th) for Canada No. 1 grade were: $3.25 to $3.50 per 75 pound bag, on a wholesale to retail basis.

Harvesting of the intermediate crop throughout Central Ontario is expected to be earlier than usual this year, with substantial quantities being available early in August.

There is a keen interest in the scab investigational project, and many growers are anxious for results of practical value.—(R. E. GOODIN.)

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NEW BRUNSWICK, N. J.

INDICATOR PLANTS FOR STUDIES WITH THE LEAFROLL VIRUS OF POTATOES[1]

HUGH C. KIRKPATRICK[2]

Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture, Wenatchee, Wash.

The ideal indicator plant for transmission studies with an insect-transmitted virus, such as that of leafroll, should develop distinct and unmistakable symptoms in a short time whenever inoculated by a single insect. In addition it should be a plant that can be grown from true seed, thus minimizing the likelihood of retention of the virus from a preceding generation. It should be possible to use this plant in the early seedling stage to permit the use of smaller pots and cages and to decrease to a minimum the time necessary for conducting an experiment. The plant must be a favorable food plant for the insect vector.

The potato is not satisfactory as a test plant in transmission studies of the leafroll virus because of the long period of time required for symptom development. Under greenhouse conditions in New York State, symptoms developed from current season infection are often un-

[1]Preliminary report presented at the joint meetings of the Potato Association of America and American Phytopathological Society, 1948 (3).

[2]Associate Pathologist formerly of Department of Plant Pathology, Cornell University, Ithaca, New York.

recognizable. To determine infection it is necessary to grow the potatoes to maturity and to index the tuber progeny. In New York it is difficult or impossible to recognize second generation symptoms in greenhouse grown potatoes during certain seasons of the year. These conditions affect directly the reliability of experiments conducted during the late fall and early winter months.

In most seed potato lots there is a certain amount of natural infection which must be detected and eliminated before conducting experiments in which the potato is used as the test plant.

Because of these distinct disadvantages in the use of potato as an indicator plant it was felt that other Solanaceous species should be investigated as possible indicator plants.

Species Used

Of the comparatively few other hosts of the leafroll virus reported in the literature prior to the initiation of this work, only *Datura stramonium* L. and *D. tatula* L. appeared to have possibilities as indicator plants (1). Dykstra reported that these species are susceptible to the leafroll virus and develop reasonably distinct symptoms.

In 1946 it was learned from Dr. Bonde[3] of the Maine Agricultural Experiment Station that he and Dr. Hovey had discovered that *Physalis angulata* L. is a good indicator plant for this virus. Consequently, this species was used in these investigations being reported.

During investigations on the host range of leafroll virus it was discovered that *Physalis floridana* Rydberg is susceptible. Since it develops symptoms soon after infection it also was used in later tests.

Methods

All experiments were carried out in the greenhouse. Seeds were germinated in flats or large pots and the plants were transplanted to 3-inch pots as soon as the first leaves had developed. The insect vector was in all cases *Myzus persicae* Sulzer. The viruliferous insects were colonized in an insectary chamber on *Datura stramonium* plants infected with leafroll virus. Wingless adult aphids were transferred from the source plant upon which they had been raised to the test plant by means of a fine camel-hair brush. After the insects were put on the test plants, the plants were covered with 2 x 6-inch Pyrolin cylinders covered on the top with fine mesh cheesecloth. Caging in this manner had no noticeable effect on the plants since they were seldom caged longer than

[3]Personal communication to Dr. A. Frank Ross, 1946. This work was later reported (2).

5 or 6 days. After the insects had fed on the test plants for the 5 or 6-day feeding period the cages were removed and the plants fumigated with nicotine sulphate vapor.

SYMPTOMS

The symptoms in infected *Datura stramonium* plants are most pronounced in the primary leaf as you will note in figure 1. As the plants

FIG. 1. Leafroll-infected *D. stramonium* (left) with non-infected plant (right). Note the interveinal yellow blotching of the primary leaves.

grow older symptoms eventually develop in other matured leaves. The most characteristic symptom is the development of interveinal chlorotic areas with indistinct margination. There is often a slight cupping of the primary leaf and of the next developed leaf. Stunting of the plant is slight.

The most typical symptom developed by *Physalis angulata* is a marked rolling of the leaves as shown in figure 2. The plant is stunted and the leaves develop indistinctly marginated yellow areas. The symptoms in this species are much more distinct than those of *D. stramonium*.

Stunting of the plant is the most striking symptom developed by infected *Physalis floridana* as you will observe in figure 3. The internodes are much shortened and the leaves are smaller than are those of corresponding non-inoculated plants. The characteristic yellowing of the primary leaves is more indefinitely marginated in this species than

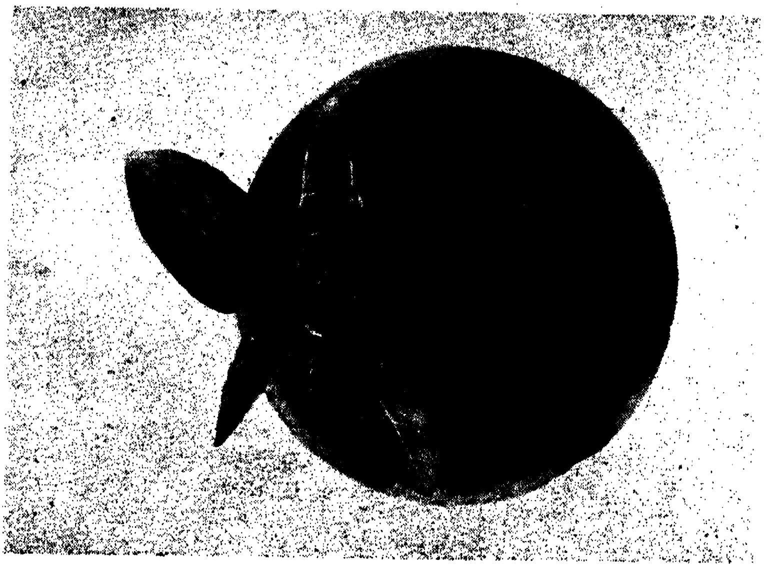

FIG. 2. Leafroll-infected *P. angulata* showing the marked rolling, stunting and indistinct interveinal yellowing.

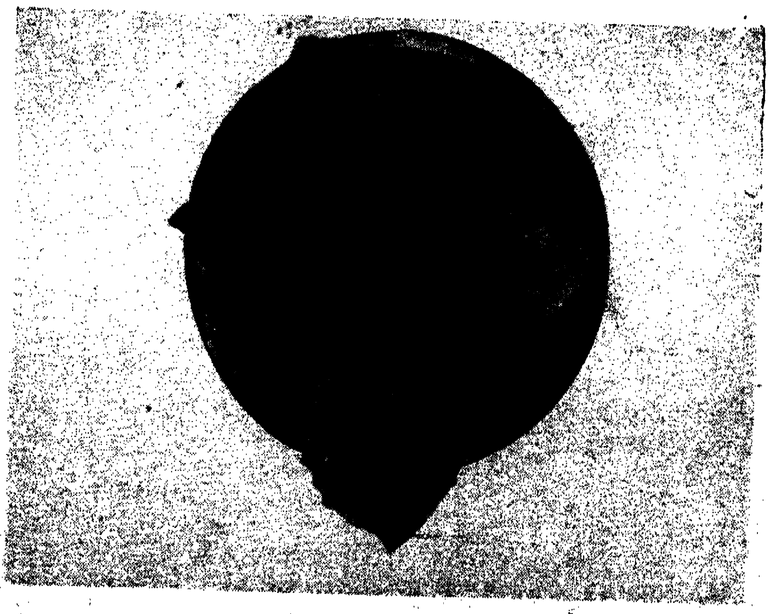

FIG. 3. Leafroll-infected *P. floridana* showing the marked yellowing, indefinite rolling of the leaves and shortened internodes.

in *D. stramonium*. A slight cupping of the yellowed leaves may or may not occur.

The symptom development in the *Physalis* species is more rapid than in *D. stramonium*. The distinct stunting of *P. floridana* and the marked rolling of the leaves of *P. angulata* are more reliable expressions of infection than is the interveinal yellowing of *D. stramonium* leaves.

SUSCEPTIBILITY

The number of successful infections obtained by quartering single viruliferous aphids on individual plants is lower with *P. angulata* than with *P. floridana* or *D. stramonium*. Comparing the transmission by single aphids in three experiments, the percentage of transmissions to *D. stramonium* was nearly three times as great as that to *P. angulata* as indicated in table 1. In two experiments comparing transmission to *P. angulata* and to *P. floridana* the transmission to *P. angulata* was about ten per cent higher than in the three previous experiments, but the transmission to *P. floridana* was about 2.7 times that to *P. angulata*. The transmission to the three indicator species by single insects was determined in a single experiment as shown in table 2. Seventy per cent of the *D. stramonium* and of the *P. floridiana* plants were infected, but only 22 per cent of the *P. angulata* plants were infected.

TABLE 1.—*Transmission of leafroll virus by single aphids to P. angulata, D. stramonium, and P. floridana*

Indicator Species	Number of Tests	Number Test Plants	Plants Infected No.	Plants Infected Per cent
P. angulata	3	102	23	22.5
D. stramonium		92	60	65.2
P. angulata	2	200	65	32.5
P. floridana		200	168	84.0

TABLE 2.—*Transmission of leafroll virus by single aphids to P. angulata, D. stramonium, and P. floridana*

Indicator Species	Number Test Plants	Plants Infected No.	Plants Infected Per cent	Symptom Development Days
D. stramonium	50	35	70.0	30
P. angulata	50	11	22.0	20
P. floridana	50	35	70.0	15

It is apparent from these experiments that *D. stramonium* and *P. floridana* are more easily infected by single insect transmissions than is *P. angulata*. The rate of symptom development is most rapid in *P.*

TABLE 3.—*Total transmission at three aphid levels to P. angulata, D. stramonium and P. floridana*

Indicator Species	1 Aphid			5 Aphids			10 Aphids		
	No. Test Plants	Plants Infected		No. Test Plants	Plants Infected		No. Test Plants	Plants Infected	
		No.	Per cent		No.	Per cent		No.	Per cent
P. angulata	415	114	27.5	295	151	51.2	237	186	78.5
D. stramonium	153	87	56.9	10	7	70.0	127	83	65.4
P. floridana	1922	1349	70.2	60	59	98.3	—	—	—

floridana and slowest in *D. stramonium.* The three indicator plants were compared at levels of one, five, and ten viruliferous aphids as observed in table 3. Where one or five insects per plant were used the per cent transmission to *P. floridana* was greater than that to either of the other two species. *D. stramonium* was more easily infected than *P. angulata* with one or five insects, but when there were ten insects per plant *P. angulata* had the greater infection percentage.

Discussion

From the results presented it is apparent that *Physalis floridana* more nearly meets the requirements of an ideal indicator plant than do *P. angulata* and *Datura stramonium.* It develops distinct and unmistakable symptoms in a comparatively short period of time. Infection percentages have been obtained with this species ranging from 70 to 100 per cent from single insect transmissions. These figures are higher than those for any other insect-transmitted virus found reported in the literature. Plants of this species can be used in the seedling stage and there apparently is no virus transmission through the seed.

Each of the other two species possesses some but not all of these advantages. Both can be used as seedlings and in neither case is there any evidence of seed transmission of the virus. *D. stramonium* is almost as easily infected as *P. floridana,* with recorded infection percentages ranging from 40 to 70 per cent. Symptoms are much slower in developing in this species and they are much less distinct. On the other hand, *P. angulata* is intermediate with respect to the time required for symptom expression, but the symptoms developed are as distinct and as easily recognized as are those in *P. floridana.* The infection percentages with single insects, however, are much lower than those for either of the other species, ranging from 20 to 40 per cent.

Whether or not one or more of these indicator species could be used to advantage for indexing seed potato samples in the greenhouse during the winter months is yet to be determined. Preliminary results have indicated that *Myzus persicae* can not pick up the virus from infected potatoes as readily as it can from infected *D. stramonium.* The results reported here are from experiments in which the viruliferous aphids were colonized on infected *Datura stramonium.*

Summary

Physalis floridana, P. angulata, and *Datura stramonium* have been demonstrated to have characteristics which make them more favorable than the potato as test plants for transmission studies with leafroll virus. All three species can be inoculated in the seedling stage and develop

distinct symptoms within 15 to 30 days following inoculation. Transmission percentages from single insect feedings generally range around 20 to 40 per cent for *P. angulata*, 40 to 70 per cent for *D. stramonium* and 70 to 100 per cent for *P. floridana*.

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STUDIES ON THE HOST RANGE OF THE GOLDEN NEMATODE OF POTATOES, *Heterodera rostochiensis* WOLLENWEBER

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The golden nematode of potatoes, *Heterodera rostochiensis* Wollenweber, was first identified in the western hemisphere on a farm near Hicksville, Long Island, in 1941. This nematode is now known to infest several thousand acres of land, all on Long Island. Yield reductions of 30 to 70 per cent have been reported from the Long Island area by Chitwood, Clement, and Gordon (1942). The golden nematode is known to occur also in England, Scotland, Wales, Ireland, Holland, Sweden, Germany, and Denmark. No way of growing potatoes on soil heavily-infested by the golden nematode, without loss, has been found in the British Isles or in other European countries. The 4, 5, or 6-year rotations practiced by potato growers on heavily-infested soil in these countries are not practical in those areas, just as they would not be practical in many of the potato-growing regions in this country.

The potato and the tomato are the only two crop plants that have been shown to be attacked by this nematode. Triffitt (1931), working in England, reported the occurrence of cysts of the golden nematode on carrot roots. This observation has not been substantiated. Negative results have been reported for many other crop plants by several workers.

Bittersweet, *Solanum dulcamara* L., was first reported as susceptible to this organism by Morgan (1925). Since then there have been several reports of the occurrence of golden nematode cysts on this plant.

No other naturalized plants or plants native to the United States have been reported as hosts. Franklin (1940) found no cysts on the roots of *Atropa Belladonna* L., an herb native to Europe and Asia, but found *Heterodera* females, containing embryonated eggs, within the roots. Miss Franklin also reported that *Solanum utile* Klotzsch, a South American species of Solanum, was strongly attacked. Ellenby (1945) presented evidence that 35 additional tuber-forming species of the genus Solanum were susceptible to the golden nematode. All European varieties of potatoes and tomatoes tested have been susceptible. Chitwood, Clement, and Gordon (1942) found that nine American potato varieties were attacked strongly.

1946 Experiments

Tests were conducted in 1946 to determine the reaction of a large number of American potato varieties to the golden nematode. Two five-hill units of each of 34 varieties* were planted on heavily-infested soil. The degree of infection on the roots was estimated by an unpublished method of Dr. B. G. Chitwood. The following is a brief description of this method. When just a small percentage of the immature females on the roots had turned from white to cream color, the roots of all varieties were dug and placed in a 15 per cent formalin preservative. Later the immature females were detached from the roots by the use of a vigorous stream of water. The immature females and roots were separated by means of a U. S. Number 25 and a U. S. Number 200 sieve, the roots collecting on the coarser screen and the immature females on the finer one. The females were then washed from the screen into a beaker. They were uniformly distributed throughout the quantity of water used to wash them from the sieve by agitation with a mechanical stirrer. Aliquot samples were taken with pipettes and the number of immature females in the aliquot samples counted. By multiplying this number by the factor, total volume/aliquot volume, the number of females per root system was calculated. After weighing the roots the number of females per unit weight of root tissue was obtained.

Large numbers of females were found on the roots of the 34 varieties. The varieties Sebago and Smooth Rural were not as strongly attacked as were the other varieties. These two varieties did not show any appreciable resistance, however.

*Smooth Rural, Sebago, Cobbler, Chenango, Mesaba, Chippewa, Earlaine No. 2, Dakota Red, Placid, Menominee, Allegheny Mountain, Seneca, Russet Rural, Bliss Triumph, Katahdin, Potomac, Pawnee, Virgil, Earlaine No. 1, Early Rose, Sequoia, Cayuga, Ontario, Mohawk, Green Mountain, Erie Russet Burbank, Pontiac, Empire, Houma, Kasota, Ashworth, Golden, Warba.

One hundred and seventy-one additional species of the flowering plants, representing 39 families, were also tested for susceptibility to the golden nematode. Many of the crop and weed plants of New York State, especially those species belonging to the Solanaceae, were included in this test. These plants were grown in infested soil and the roots were carefully pulled and examined for the presence of cysts. Wherever possible the roots of 100 plants of each species were examined. In addition, the roots of Solanaceous species and of crop plants, on which no cysts were observed by external examination, were stained and examined internally for the presence of golden nematode larvae in order to make certain that larvae had not entered the roots and then failed to develop further*. Several varieties of eggplant, pepper, and tobacco, economically important crops of the Solanaceae, were included in this test.

Only tomato and bittersweet (*Solanum Dulcamara* L.) were found to be susceptible by macroscopic examination. All 43** varieties of tomatoes were susceptible. No nematode larvae found by microscopic examination of stained roots were positively identified as golden nematode larvae.

1947 Experiments

Sixteen varieties of potatoes and six varieties of tomatoes were grown in adjacent replicated and randomized plots in order to obtain information on the relative numbers of nematodes attacking potato and tomato roots. Five plots of two plants each, for each variety, were planted on heavily-infested soil. The previously described immature cyst method for measuring the degree of infection was used for both tomatoes and potatoes. Potato and tomato roots were harvested when a small percentage of the females on the roots had turned from white to cream color.

Table 1 shows the numbers of immature females obtained from the different potato varieties and table 2 the numbers of immature females obtained from the tomato varieties. Under the conditions of this experiment the tomato roots were significantly less strongly attacked than

*Determinations were made by Dr. B. G. Chitwood, Division of Nematology, U. S. D. A.

**Yellow Plum, Ponderosa, Bonny Best, Scarlet Dawn, San Marzana, Dwarf Champion, Marglobe, Earliest of All, San Diego Stone, Bounty, Rutgers, June Pink, Spark's Earliana, Pan American, Greater Baltimore, Golden Jubilee, Victor, Valiant, Stokesdale, Pritchard, Italian Red Pear, Large Italian Plum, Early Detroit, Red Cherry, Red Plum, Yellow Pear, Stone, Oxheart, Break O' Day, Jubilee Yellow, Chalk's Special Early, Old Southhold, Long Red, Red Jacket, John Baer, Kroemer's Early, Comet, Cleo, Detroit Certified, Chalk's Early Jewel, Early Chatham, Matchless, Firesteel.

TABLE 1.—*Number of golden nematode females obtained from the roots of potatoes and tomatoes*

	No. of Immature Females	
	Females/Gram of Root	Females/Root System
Warba	138 ± 38*	4,922 ± 2,091
Chippewa	111 ± 40	2,484 ± 854
Empire	92 ± 39	2,905 ± 1,314
Fillmore	88 ± 39	3,100 ± 1,212
Chenango	84 ± 63	3,624 ± 2,071
Houma	84 ± 27	3,484 ± 1,749
Cobbler	79 ± 9	2,236 ± 978
Katahdin	73 ± 36	2.418 ± 1,235
Bliss Triumph	71 ± 48	3,585 ± 2,440
Madison	70 ± 29	2,163 ± 1,165
Green Mountain	62 ± 22	2,329 ± 409
Smooth Rural	52 ± 23	1,255 ± 892
Sequoia	51 ± 38	2,791 ± 2,295
Ashworth	46 ± 4	1,790 ± 638
Essex	46 ± 31	2,775 ± 2,288
Sebago	45 ± 27	1,285 ± 348

* Standard deviation.

TABLE 2.—*Number of golden nematode females obtained from the roots of six varieties of tomatoes*

Variety	No. of Immature Females	
	Females/Gram of Root	Females/Root
Ponderosa	30 ± 6*	314 ± 133
John Baer	18 ± 8	610 ± 307
Kroemer's Early	17 ± 9	439 ± 184
Marglobe	17 ± 7	530 ± 182
Plum	15 ± 4	379 ± 123
	10 ± 6	292 ± 86

* Standard deviation.

TABLE 3.—*Number of golden nematode females obtained from the roots of sixteen varieties of potatoes*

Plant	No. of Varieties	Immature Females	
		Per Root System	Per Gram of Roots
Potato	16	2695 ± 935*	74.4 ± 24.8
Tomato	6	427 ± 125	17.8 ± 6.7
		9999 — 1**	9999 — 1

* Standard Deviation

** Odds that a difference exists between the numbers of females obtained from potato and tomato roots—derived from use of Student's "t".

were the potato roots as shown (table 3). Equally high odds denoting significance were obtained when the potato varieties having the six lowest infection indices were compared with the six tomato varieties. The difference was greater when the number of females per root system was used as an infection index (6.3 times) than when immature females per gram of root tissue (4.4 times) were used.

Summary

In common, with European varieties, all North American varieties of cultivated potatoes and tomatoes tested were shown to be susceptible to the golden nematode. Potato varieties were more strongly attacked than tomato varieties. No other crop or naturalized or native weed plant was found to be attacked, except for *Solanum dulcamara* L., which previously had been reported as a host.

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RESISTANCE TO COMMON SCAB OF POTATOES IN PARENTAL CLONES AND IN THEIR HYBRID PROGENIES[1]

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In breeding potatoes for resistance to common scab, the usual testing procedure has been to grow the entire population of seedling families in a scab-test plot heavily infested with *Actinomyces scabies* (Thax) Gues. Individual seedling plants apparently resistant to scab were selected at harvest time, and in succeeding years their selected clones were further tested for scab resistance and for other economic characters. In the second and subsequent tests four hills of each selected clone were planted in the scab test plot. Variability in scab infection in the plot was measured by planting every fifth hill with either the Cobbler or Chippewa

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varieties, both of which are susceptible. Resistance was measured and recorded in terms of the "highest scab" method described by Leach, *et al*[2]. According to this method, a scab index ranging from 1 (shallow, superficial lesions) to 5 (deep, pit lesions) is based on scab pustule type. The reactions of the following varieties illustrate the range of these types: 1—Hindenburg; 2—Jubel, Menominee, Cayuga; 3—Intermediate (no common example available) 4—Sebago; 5—Cobbler and Chippewa.

The following study was made to determine (1) the resistance to scab in subsequent tests of seedling clones grown in the first clonal generation on relatively scab-free soil, and selected without regard to scab resistance as compared with the resistance of siblings of the above clones grown in the scab test plot and selected for resistance; (2) the relation of scab resistance in seedling clones to the clonal resistance of the parents in each cross.

Experimental Results

The data in table 1 indicate that the level of infection in the scab-test plot located at Grand Rapids, Minnesota, was fairly consistent during the two years when these studies were made. The 26 clones shown in table 1 had a mean scab index of 2.12 in 1946 and 2.31 in 1947. The

Table 1.—*Reaction to common scab of 26 seedling clones in* 1946 *and* 1947 *in the scab test plot*

1947
(Number of clones in indicated classes of scab reaction)

1946 Classes of scab reaction	1	2	3	4	Total
1	2	2			4
2	2	8	6		16
3		1	3	1	5
4			1		1
Total	4	11	10	1	26

scab indices of 3 of the 26 clones was lower in 1947 than in 1946, and those of 9 clones were higher in 1947 than in the previous year. In no case did the reaction of a clone differ by more than one type class in the two years. These results agree with previous observations that a reliable

a. Leach, J. G., F. A. Krantz, Phares Decker, and Harold Mattson. The measurement and inheritance of scab resistance in selfed and hybrid progenies of potatoes. Jour. Agr. Res. 56:843-853. Illus. 1938.

indication of scab resistance can be obtained by growing four hills of a clone in a heavily infested test plot. The susceptible Chippewa and Cobbler hills were invariably heavily scabbed indicating that conditions favorable to infection prevailed throughout the plot.

Although a consistent reaction to scab can be found by growing four hills of a clone, selection of single seedlings in the first clonal generation in the scab test plot is not a reliable method for selecting scab-resistant clones from the population of a given cross. This is shown by the data in table 2. Seventy five seedlings from several families

TABLE 2.—*Mean scab index of seedling clones selected the previous year under low and high levels of infection*

1946		1947	
Scab in Seedling Plot	Clones Selected	Index in Scab Test	Clones with Scab Index of 2 or Less
Level	Number	Index	Per cent
Low	100	3.29	19.0
High	75	3.32	18.7

selected for scab resistance in the scab test plots and 100 seedlings from the same families grown on soil relatively free from scab were planted as four-hill units in the scab plot the year following selection. Mean scab indices of 3.29 and 3.32, respectively, were found for the two groups, whereas the number of clones with an index of 2 or less was 18.7 and 19.0 per cent, respectively. It is evident that the error of selection based on one plant is too high for reliable results, and that selection for scab resistance must be made in later generations.

The relation of resistance of parent clones and that of their progeny was studied in 30 different crosses. The thirty crosses included combinations of parents having clonal reactions to scab ranging from type 1 to type 5 inclusive. The original population of 4503 was reduced to 399 by selection for characters other than scab resistance. Scab resistance was determined by growing four hills of each parent and selected seedling clones in the scab test plot. Table 3 also gives the essential data for each cross.

It will be seen from the data in table 3 that two crosses, designated numbers 34 and 59, produced progenies with the lowest mean scab indices and the highest percentages of seedling clones with indices of 2 or less. Six parents which seemed to transmit a high degree of resistance to their progeny are numbers 51, 56, 59, 64, 52, and 53.

Wide differences in scab resistance are apparent in the progenies of crosses between different parents of equal resistance. For example,

TABLE 3.—*Reaction to common scab of parents and progeny of thirty crosses*

Designate of Cross	Type of Parental Resistance	Parental Designate	Seedlings of Cross	Seedling Clones Tested	Number of Seedling Clones in Indicated Classes of Scab Resistance					Mean Scab Index	Seedling Clones with Index of 2 or Less
			Number	Number	1	2	3	4	5		Per cent
34	2 and 3	51 x 52	179	12	2	4	4	2	0	2.50	50
99	2 and 3	56 x 58	163	18	0	7	4	3	4	3.22	39
186	2 and 3	63 x 52	90	5	0	0	1	4	0	3.80	0
15	3 and 3	53 x 54	74	15	0	1	2	2	10	4.40	7
20	3 and 3	61 x 52	181	10	0	1	5	3	1	3.40	10
59	3 and 3	64 x 52	159	18	2	6	7	3	0	2.61	44
60	3 and 3	53 x 52	63	8	0	2	3	3	0	3.13	25
66	3 and 3	65 x 52	108	5	0	1	4	0	0	2.80	20
101	3 and 3	53 x 68	193	17	0	4	5	6	2	3.35	23
104	3 and 3	67 x 52	299	39	0	0	9	2	18	4.23	0
105	3 and 3	53 x 69	309	10	0	2	3	2	3	3.60	20
118	3 and 3	54 x 52	284	22	0	1	6	8	7	3.95	4
161	3 and 3	67 x 71	181	6	0	1	1	4	0	3.50	17
32	3 and 3	71 x 68	97	5	0	0	1	4	0	3.80	0
131	3 and 3	73 x 71	146	14	0	0	3	11	0	3.78	0
133	3 and 3	73 x 68	161	13	0	0	2	10	1	3.92	0
134	3 and 3	73 x 52	155	18	0	0	2	16	0	3.89	0
96	3 and 3	67 x 54	190	7	0	1	3	2	1	3.43	14
98	4 and 2	62 x 51	191	16	0	3	6	6	1	3.31	19
28	4 and 2	62 x 63	74	7	0	0	3	3	1	3.71	0
120	4 and 2	62 x 56	53	5	0	1	0	1	3	4.20	20
69	2 and 4	56 x 66	136	16	0	3	6	7	0	3.25	19
44	1 and 5	59 x 60	126	25	1	2	8	10	4	3.56	12
35	5 and 2	55 x 56	173	15	0	1	2	2	10	4.40	7
179	5 and 2	60 x 56	50	6	0	1	0	1	4	4.33	17
116	2 and 5	70 x 60	192	15	0	0	8	4	3	3.60	0
10	4 and 3	62 x 59	210	7	0	1	0	4	2	4.00	14
173	4 and 3	62 x 52	150	27	0	1	5	21	0	3.70	4
90	4 and 3	60 x 68	116	12	0	0	1	10	1	4.00	0
42	4 and 5	57 x 58	90	6	0	0	1	4	1	4.00	0

cross 104 (67 x 52) produced progeny with a mean scab index of 4.23. This suggests that these two parents have a low combining value when crossed, because each of them when crossed with other parents with the same clonal resistance, produced progeny with more than average resistance. Thus cross 59 (64 x 52) produced seedlings with a mean scab index of 2.61, and the progeny of cross 96 (67 x 54) have a mean scab index of 3.43. All of the parents involved in these three crosses have a clonal scab reaction of type 3.

Nevertheless, a general association was found between the resistance of the parent clones and their hybrid progeny. This is shown on table 4 where crosses of parents with the same clonal resistance are combined. The three crosses between parents with scab indices of 2 and 3 produced the most resistant progenies, these having a mean scab index of 3.17 and 37 per cent of clones with an index of 2 or less. Fifteen crosses between parents with type 3 scab reactions, four between parents of types 2 and 4 and one cross between parents with indices of 1 and 5 produced progenies with mean scab indices of 3.71, 3.45, and 3.56, respectively, and had 11, 16, and 12 per cent of seedlings with indices of 2 or less. Crosses of parents with indices of 2 and 5, 3 and 4, and 4 and 5 resulted in progenies with indices of 4.08, 3.85, and 4.00, respectively, and 6, 4, and 0 per cent of clones with indices of 2 or less.

The rather wide differences in the scab resistance in progenies from crosses between parents of the same clonal resistance may be partly due to the original source of resistance. The most resistant parents used in these studies derived their resistance from either Hindenburg, Jubel or Arnica. In table 5 eighteen crosses are arranged according to different combinations of parents deriving their scab resistance from these varieties. These data suggest that when both parents of a cross have derived their resistance from the same source, the progeny may be less resistant than when resistance from two sources is combined. In crosses of parents with resistance of types 2 and 3, combining germ plasma from Hindenburg and Jubel appeared to result in more resistance in the progeny than when Jubel was the sole source of resistance. Likewise in crosses between parents with scab indices of 3, there appear to be fewer seedlings with indices of 1 and 2 when both parents were derived from Hindenburg than when the two parents differed in their source of resistance.

TABLE 4.—*Resistance to scab of seedling clones from combinations differing in parental resistance*

Parental Resistance	Crosses	Seedling Clones Tested	Number of Seedling Clones in Indicated Classes of Scab Resistance					Mean Scab	Seedling Clones with Index of 2 or Less
Indexes	Number	Number	1	2	3	4	5	Index	Per cent
2 & 3	3	35	2	11	9	9	4	3.17	37
3 & 3	15	207	2	20	56	86	43	3.71	11
2 & 4	4	44	0	7	15	17	5	3.45	16
1 & 5	1	25	1	2	8	10	4	3.56	12
2 & 5	3	36	0	2	10	7	17	4.08	6
3 & 4	3	46	0	2	6	35	3	3.85	4
4 & 5	1	6	0	0	1	4	1	4.00	0

TABLE 5.—*Scab resistance of crosses whose parental resistance was obtained from different sources*

Parental Resistance	Source of Resistance	Crosses	Seedling Clones Tested	Number of Seedling Clones in Indicated Classes of Scab Resistance					Mean Scab	Seedling Clones with Index of 2 or Less
Indexes		Number	Number	1	2	3	4	5	Index	Per cent
2 & 3	H and J	2	30	2	11	8	5	4	2.93	40
2 & 3	J and J	1	5	0	0	1	4	0	3.80	0
3 & 3	H and J	6	112	2	9	33	42	26	3.72	10
3 & 3	H and A	3	42	0	7	10	10	15	3.79	17
3 & 3	A and J	1	8	0	2	3	3	0	3.13	25
3 & 3	H and H	5	45	0	2	10	31	2	3.73	4

Summary

1. Selection of individual plants in seedling families in the scab test plot was relatively ineffective in isolating scab resistant seedlings.
2. Consistent ratings for mean scab index were obtained by growing four hills of a clone in a heavily infected scab test plot.
3. Crosses between parents of the same clonal resistance resulted in progenies which differed widely in the percentage of resistant seedlings.
4. Crosses between parents derived from the same resistant ancestor seemed to produce progeny of slightly lower resistance than where the two parents had different resistant ancestry.
5. A test of 399 selections from 30 crosses showed that when both parents had a scab index of 3 or less, from 11 to 37 per cent of the selections had an index of 2 or less, and from 43 to 63 per cent an index of 3 or less.

UTILIZATION OF WHITE POTATOES[1]

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The normal annual crop of potatoes in the United States is about 375 million bushels. As shown in the chart, 86 per cent of the crop is used for table stock and seed. The remaining 14 per cent, 53 million bushels, goes into various feed and industrial uses.

In addition to the potatoes consumed directly as food, an estimated 22 million bushels are used as raw material for food-processing. More potatoes are used for the manufacture of chips than all other food-processing outlets combined. The figure for potato consumption for chips alone in 1947, released after the chart was prepared, was 20 million bushels, as compared with 15 million bushels in 1946.

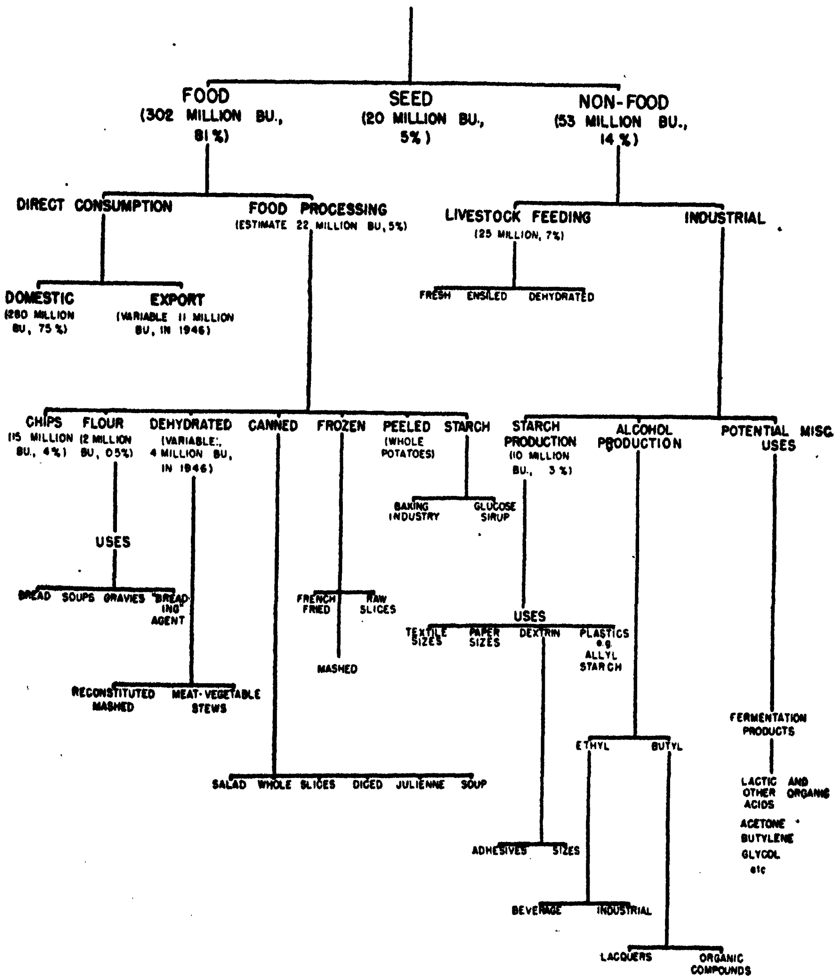
The 2 million bushels of potatoes processed into flour might be considered normal. From 15 to 20 million pounds of flour are produced

[1]Report of a study made under the Research and Marketing Act of 1946.

[2]One of the Laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, United States Department of Agriculture.

UTILIZATION OF WHITE POTATOES

RMAL ANNUAL UNITED STATES CROP, ABOUT 375 MILLION BUSHELS
(QUANTITY OF POTATOES AND PERCENTAGE OF TOTAL PRODUCTION
GOING INTO EACH OUTLET GIVEN WHERE DATA ARE AVAILABLE)



EASTERN REGIONAL RESEARCH LABORATORY
BUREAU OF AGRICULTURAL AND INDUSTRIAL CHEMISTRY
UNITED STATES DEPARTMENT OF AGRICULTURE

annually. During the past year, however, the production of potato flour has been increased to several times this amount. This augmented production is being sent largely to France and other European countries as a part of the emergency food program.

The quantity of potatoes used in dehydration for food was more than 20 million bushels in 1943 and 1944. Most of this product was used for the armed forces. This outlet is now stabilized at approximately 4 million bushels—the 1946 figure.

In the non-food uses, livestock feeding is the largest single outlet; 25 million bushels are consumed in this manner each year. Starch production usually occupies the second position, using about 10 million bushels of potatoes annually. Only about 5 per cent of the potato starch is used for food. During some recent years in which we have had surplus potatoes and a scarcity of corn, large amounts of potatoes have been used for alcohol production. This figure was highest in 1946, when more than 29 million bushels of the 1946 crop were processed by distillers. Fewer potatoes however, were used for alcohol during 1947.

The data in the chart were obtained from the Bureau of Agricultural Economics and the Potato Division, Production and Marketing Administration, of the U. S. Department of Agriculture, from the National Potato Chip Institute, and from processors of potatoes in the food and starch industries.

For a more complete discussion of the current situation in utilization of potatoes, readers are referred to the writer's article, "Industrial Utilization of Cull and Surplus Potatoes," which appeared in the November 1947 issue of the American Potato Journal.

SECTIONAL NOTES

CONNECTICUT

Excessively heavy rainfall, especially in the Connecticut valley during May and June, resulted in nitrogen, and particularly magnesium deficient potatoes, in some fields. Where magnesium deficiency of potatoes was found, it was learned that magnesium limestone had not been applied to the fields in recent years nor had a soluble source of magnesium been included in the fertilizer applied for the crop. Where the magnesium deficiency was not serious two or three applications of 20 pounds of epsom salts per acre were included in the spray solution, and were applied about one week apart. Twenty to thirty pounds of

epsom salts could be added with 8-4-100 Bordeaux-DDT solution and about forty pounds could be included per 100 gallons of Dithane-DDT solution. Where magnesium deficiency of potatoes was very serious, a separate application of epsom salts alone in water at the rate of 100 pounds per 100 gallons per acre was recommended.

It was also recommended to the Connecticut growers, that to prevent magnesium deficiency conditions occurring in the future, potato soils should be limed with magnesium limestone according to recommendations based on a soil test. Also, that until the magnesium applied in the field applications of magnesium limestone becomes available in sufficient quantity, a soluble source of magnesium should be used in the potato fertilizer.

Some growers are spraying 2,4-D at the rate of ¾ pound of the free acid as the sodium salt per acre to control weeds in potato fields. At this rate no serious injury to the potato leaves was noted but morning glory was killed, and both smartweed and ragweed considerably injured. (ARTHUR HAWKINS).

INDIANA

This past week there was held a potato field day in northern Indiana and it is quite interesting to see the advancement the potato growers have made in the last ten or fifteen years—not only on the method of handling and producing better potatoes but also in regard to the field. The commercial growers on the black sand and upland soils are already starting to harvest Irish Cobblers and the potato operations will continue until the middle of September or the first part of October in the northern part of the state and a little bit later in the southern part.

We have a few fields that were slightly damaged by late blight due to the fact that some of our growers failed to follow the spray schedule regularly. Some growers with an acreage of 300, 400 and 500 acres, of early Cobblers are harvesting from 400 to 450 bushels of U. S. No. 1 potatoes per acre. With fewer acres and better care, it is apparent that we will top all production records in our state.

Quite a few of the larger growers, especially in the northern part of the state, are setting up irrigation plants—using portable pipes—and are able to irrigate from 40 to 50 acres per day from a single unit. In some instances, the overhead irrigation has accounted for some of the better yields but, for the most part, our yields will be high this year. (W. B. WARD).

MAINE

In general the weather throughout northern Maine has been somewhat dry, but as yet it is not dry enough to affect the crop materially. Some farmers indicate that it is just right, and that they would rather have a quality crop than a tremendously large one. There has been some late blight reported, but it has not reached the epidemic form, and is not serious at present. Dusting by helicopter and airplanes is being practiced by many farmers. The effectiveness of these methods will not be known until the crop is harvested, but last year helicopter dusting seemed to work very satisfactorily.

The insect situation is not serious. Every one is using DDT for nearly every application. Reports indicate that about one hundred mechanical-beaters will be used in the county this year for potato top killing purposes. Last year about ten sulphuric acid machines were used, but this year growers have discontinued their use, except in one case where a farmer has used one for four years.

It is expected that farmers will have an opportunity to vote on a proposed marketing agreement about September first.

In view of the activity in potato house construction potato storage should be more plentiful than usual. It seems that there is a lot of construction this year. (VERNE C. BEVERLY).

NEW JERSEY

Our New Jersey growers have harvested practically all their Cobblers and Chippewas and many are beginning to harvest Katahdins. The market is very dull, and the government is buying substantial quantities in its program to support prices. Most of these potatoes purchased by the government are being converted into flour at the Publisher Distilling Plant at Philadelphia.

The yields, in general, are slightly below those of last year but are higher than was indicated a month ago. The heavy rainfall during May and June caused wide-spread deficiencies of nitrogen, and magnesium. The fact that many growers side-dressed, sprayed or dusted their potatoes with nitrogen, magnesium or a complete fertilizer has resulted in better yields than anticipated.

Many growers are killing their potato vines with herbicides or mechanical-beaters, not only to facilitate harvesting, but to prevent the infection of the tubers with blight which is prevalent in some fields.

NEW YORK

The acreage entered for seed certification is about the same as in recent years. Field inspections support the evidence obtained from

the Florida tests that leafroll is only about one-half as abundant as last year and one-quarter as much as two years ago. Few fields are being rejected for virus diseases. Much of the seed from outside areas, Maine, Ontario and Prince Edward Island is being used and this is also as good or better than usual. Spindle tuber is a little more prevalent but still there is only a small trace. Late blight in upstate New York was first observed on the 28th of July. Although this is an early date, the weather has been so favorable for it that we are surprised not to have seen it earlier. Growers of new varieties continue to have great difficulty in getting them certified. There is a good prospect for certification on 56 acres of Essex, 8 of Empire and 6 of Chenango. Ontario seems to have established itself with an entrance of 114 acres. (K. H. FERNOW).

The acreage of potatoes entered for certification is somewhat under that of last year. The quality of seed seems to be much improved even in commercial fields. Cooperative research work on leafroll is being carried jointly between state and county. The most offending insects seem to be peach and potato aphids. Various dusts are being used experimentally and also commercially. The two that appear to give the best results are DDT dusts, the first being a 4½ per cent DDT with 2 per cent oil; and the second known as D-Fusol 4, about 85 per cent of fused sulfur with 4½ to 5 per cent DDT. In the case of the latter some good results have been reported by adding a 1 per cent oil to it. These dusts are applied by ground machines but later in the season, when it is impossible to get this machinery through the fields, planes will be used and Vapona (4½ to 5 per cent DDT in oil) is sprayed on at approximately 7 gallons per acre. The above program, combined with good seed and better care and attention, seems to be giving results in leafroll control.

The total acreage of potatoes in the Klamath area is only slightly higher than the small crop of 1947. approximately 5 per cent. Climatic conditions have been favorable to date and both the stands and growth are excellent. (C. A. HENDERSON).

SOUTH DAKOTA

Harvesting operations of early potatoes started in South Dakota on the 2nd of August and the washed Bliss Triumphs shipped from Watertown have topped the market in Chicago. Digging will be quite general in the Clark area on the 16th of August. Yields reported to date have been very good—running from 200 to 250 bushels per acre.

All growers, who planted within their potato acreage allotments, have signed up with the P. and M. A. and will offer their number 2 and grade-outs to the Government. Only three cases of over-planting have come to the attention of the P. and M. A. officials to date and these growers will be unable to market their number 2 potatoes or grade-outs if a marketing order is recommended by the committee.

The South Dakota Potato Committee will meet on the 13th of August to consider marketing recommendations for a marketing order. There are seven counties in the Northeastern part of South Dakota that are included in the area which will be covered by any marketing agreement. (JOHN NOONAN).

CANADA

The sales of certified seed potatoes in Canada from the 1947 crop far exceeded those for any previous year. Over four and a quarter million bushels of seed were exported to nineteen countries, and nearly two and one-half million were used within the country. The previous high record of sales took place in 1946, when more than five million bushels were sold.

Applications for field inspection in 1948 have set a new high record. Nearly 70,000 acres have been entered for inspection. The Katahdin variety accounted for 22,290 acres; Green Mountain, for 8,936; whereas the remaining acreage represents a large number of varieties varying from 2,500 acres to a fraction of an acre. In Prince Edward Island 38,754 acres have been entered, compared with 33,496 in 1947. In New Brunswick, 19,990 were entered, compared with 16,360 in 1947. British Columbia showed a marked increase, with 3,098 acres entered in 1948, compared with 2,598 in 1947.

All reports indicate that there should be a good crop harvested this year. In some areas the crop is uneven because of late planting, but good growing conditions have prevailed since that time, and the crop is doing nicely. Aphids are beginning to appear in certain areas in New Brunswick, and growers have been warned to rogue early, spray thoroughly, and to practice top-killing. (J. W. SCANNELL).

PROVINCE OF ONTARIO

There is some variation in the development of the potato crop, with growth about normal in most areas. The weather, during the early part of the season materially affected tuber setting in such extensive potato growing sections as North Simcoe and Parry Sound districts. Crops in practically all areas would now benefit by more moisture and

unless there are general rains at an early date the potential crop is likely to be greatly reduced. The blight disease has been reported from Dufferin, Simcoe, Temiskaming, Cochrane, Wellington, Oxford, Elgin, Middlesex and Lanark counties, although the weather has been cool and rather dry. Norfolk County reports that "rain is needed to develop tubers." Algoma says "more moisture needed." Manitoulin states that "potatoes got away to poor start owing to dry spell." Middlesex reports "crop later than average."

Harvesting and marketing of the early crop in Southwestern Ontario is about complete, with growers of the intermediate crop starting to market small quantities. Digging has been delayed because of the pressure of harvesting and late haying operations on farms. Prices have advanced and are now holding firm, with quotations at Toronto, wholesale to retail, Canada No. 1 grade $1.85 to $2.10 per 75-pound bag. Some markets are even higher.

The 1948 acreage is now estimated at 115,300 which is about 5,000 acres less than 1946.

Growers are giving increased attention to the cultural care of the potato crop by spraying or dusting. There is an almost complete absence of Colorado potato beetles, and where DDT applications have been properly applied, leafhopper and flea beetle injury are almost *nil.*

PROVINCE OF QUEBEC

The potato situation for the Province of Quebec on the 1st of August is very promising.

With an estimated acreage of 151,700, to compare with 148,700 acres in 1947, the numerical condition of yield is 102, which is 2 per cent above the long time average yield per acre of 100. Only two districts are below this long time average and the dry weather is the main cause.

As far as insects are concerned, the situation is normal. Late blight appeared in the southwestern part of the province. The situation, however, is normal elsewhere. (ROGER GAGNON).

AMERICAN POTATO YEARBOOK

The American Potato Yearbook, believed to be the first reference book covering the potato field, has just come off the press. Edited by John C. Campbell, Rutgers University College of Agriculture and endorsed by the Potato Association of America, this book contains sixty pages of interesting and vital information to the potato grower, the po-

tato dealer and shipper, the potato research specialist and all those with an interest in the potato industry.

Of special significance is the list of nearly one hundred recent references to potato culture in the United States as compiled by the Library of the Department of Agriculture. The Yearbook also tells you how and where you can secure other helpful brochures and leaflets covering various phases of the potato industry. Additional features include a list of leading associations engaged in the potato industry together with the names of those in charge of seed certification in our states and Canada.

The book contains much statistical information of vital importance. There are tabulations by states of both seed and table stock production and stocks on hand as of January 1, 1948. There are statistics on Canadian and world potato production. There is also a list of the 100 leading potato growing counties in the United States. Other features include a classified directory of business concerns serving the potato industry, a list of monthly and quarterly publications in the potato field, a history of the origin of the potato and details on its food value and composition.

Copies of the Yearbook may be secured from the American Potato Yearbook, Business Office, 289 Fourth Avenue, New York 10, N. Y. An individual copy sells for $2.00.

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LEAFHOPPER CONTROL WITH DDT IN RELATION TO LENGTH OF SEASON, QUALITY AND YIELD OF SEVENTEEN POTATO VARIETIES

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The potato leafhopper, *Empoasca fabae* Harris, is undoubtedly the worst pest of potatoes in Illinois. Leafhopper feeding causes premature death of vines and a reduction in quality (starch content) and yield. Under these conditions potato varieties are extremely difficult to evaluate for qualities other than leafhopper resistance. Furthermore, the degree of leafhopper resistance, in itself, to say nothing of other characteristics cannot be determined with any exactitude unless perfect or near-perfect control of these insects can be achieved for comparative purposes. Prior to the advent of DDT, such control was difficult if not impossible. With DDT almost perfect control can be obtained (3, 6, 18, 19, 20) without

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the complications of insecticidal phytotoxicity (5) and infestations can be reduced sufficiently to illustrate the extremely marked effects of low leafhopper populations on yields (20).

Potato varieties vary widely in their susceptibility to hopperburn (1, 2, 10, 12, 13, 14), ranging from the very susceptible Bliss Triumph and Pontiac to resistant Sequoia. Investigators are not in agreement, however, as to why some varieties are more severely damaged than others. Early varieties have been claimed to be more susceptible than later kinds, but Allen *et al* (2) state that relative earliness or lateness is not the prime factor. In their experiments the early varieties Bliss Triumph and Warba proved more attractive throughout the season than the later varieties, Katahdin and Houma. Sleesman and Stevenson (14) point out that the correlation between earliness and susceptibility may be a pseudo-relationship since it is difficult to distinguish between maturity necrosis and that caused by leafhoppers. Allen and Rieman (1) were of the opinion that the leafhopper tolerance exhibited by Katahdin and Houma might account in part for the heat and drought resistance attributed to these varieties by several investigators.

The differential response to leafhopper control has been reported for several varieties but other important and coincidental yield-depressing factors such as phytotoxicity of insecticides and fungicides, and damage from diseases have been difficult to measure. Sleesman and Bushnell (13) used Bordeaux mixture on 13 varieties and found that those with hopperburn ratings between Sequoia (none - light) and Bliss Triumph (severe) generally responded with uniform yield increases. However, Bonde *et al* (4) and Horsfall and Turner (7) have pointed out that Bordeaux mixture is phytotoxic under some conditions and may reduce yields in the absence of pests. The dwarfing effect of Bordeaux mixture is often masked by disease and insect pest control, and yield reductions from its use may amount to as much as 13 per cent in Cobbler (7). Willson and Sleesman (19) by using a combined spray of DDT and a fixed copper were able to reduce leafhopper damage to insignificance on 10 varieties. Nymphal populations which averaged less than one individual per leaf on unsprayed plants were accompanied by "comparatively" severe blight infection. Thus the two factors—insects and a defoliation disease—could not be evaluated separately.

Potato virus diseases have been overlooked or their incidence not reported in practically all investigations concerning leafhopper susceptibility and varietal response to leafhopper control. Yet it is not uncommon to find 10 per cent or more leafroll in certified stocks, particularly in susceptible varieties such as Chippewa. The yield-depressing effect of such

virus diseases as leafroll and spindle tuber is well known. Leafroll in particular causes a reduction in both number and size of tubers. Tuthill and Decker (16) calculated that losses from leafroll in Chippewa ranged from 2.8 per cent for 10 per cent leafroll to 40.7 per cent for 100 per cent infection; and yield reductions in Cobbler from 3.7 to 53.0 per cent, respectively. LeClerg *et al* (9) reported no difference in per cent yield reduction from leafroll between Katahdin and Cobbler over a period of several years and in various states. Per cent losses in yield for the two varieties ranged from 3.2 with 4 per cent leafroll to 57.1 with 100 per cent infection. They state further that the reduction in yield from 8 per cent or less leafroll is relatively small from the standpoint of the commercial grower. Kirkpatrick and Blodgett (8), using data from yields of Chippewa, Cobbler and Green Mountain as well as data from Tuthill and Decker, derived an equation by which it was claimed the yield potential of any leafroll-free variety, strain or plot could be estimated from the yield of leafroll contaminated stock. Sleesman and Stevenson (14) considered the detection of rugose mosaic, leafroll and spindle tuber of importance in breeding for leafhopper resistance since plants affected with these diseases suffer more from leafhopper feeding than healthy ones.

The bases for measuring varietal responses to leafhopper control have been adult and nymphal populations, severity of hopperburn and yield increases, with but little emphasis on increase in starch content of the tubers. Sleesman and Wilson (15) found a high negative correlation between nymphal populations and yield, between dead foliage and yield, and a high positive correlation between nymphs and dead foliage. Apple and Arnold (3) reported a highly significant correlation coefficient of —.87 between nymphal populations and specific gravity of the tubers. They used pounds of starch per acre as a criterion for measuring potato leafhopper control with 11 different insecticides.

The striking increases in length of season among potato varieties due to leafhopper control with DDT has not been stressed thus far. Yet the widespread adoption of DDT for use on potatoes means that revisions may be necessary in "days-to-maturity" for most varieties where leafhoppers are an annual problem. Length-of-season increases, resulting from the application of DDT, might well be of some importance to potato growers who must place their crop on an early market.

Experiments were conducted in 1946 to determine the effect of leafhopper control with DDT—in the absence of fungicides—on length of season, quality and yield of several old and certain relatively new potato varieties. An attempt was made to eliminate or to record and evaluate, where possible, factors other than leafhopper feeding that might depress

yields. It was hoped that information from these tests might indicate the relative susceptibility of some of the newer as well as older varieties to leafhopper feeding under Illinois conditions, and those varieties on which DDT could be used most profitably from the standpoint of improving both quality and yield. Although these experiments represent only one year's work, it is hoped that the results will illustrate some of the difficulties involved in measuring varietal response to leafhopper control.

The decision to attempt an evaluation of varieties in the absence of fungicides, involving a risk of infection with foliage diseases, was based on two major premises, namely, incidental leafhopper control with fungicides and phytotoxicity from these materials. Although Heuberger and Stearns (6) showed that Zerlate and Compound A have no additive effect on leafhopper control when combined with DDT, their data and those of Wilson and Sleesman (18) demonstrate that many fungicides when used alone on potatoes provide some measure of leafhopper control. Therefore, a true measure of varietal response to an insecticide such as DDT would be difficult, were a fungicide with some insecticidal properties applied to plots not receiving DDT. From the standpoint of phytotoxicity almost any fungicide may conceivably have a depressing effect on vine growth and tuber development which may not be readily measured or even detected.

Materials and Methods

Seventeen varieties ranging in season from very early to very late were chosen. All were northern-grown certified stock with the exception of Pawnee which was War-approved. Two plantings were made, one at Urbana, Illinois on the 13th of April containing mostly early to midseason varieties and the other at Des Plaines (Cook County) on the 23d of May consisting largely of late kinds. A few varieties which had not been tested over a long enough period of time in Illinois to determine their characteristics or adaptability were planted at both locations. Each of the two plantings was made up of two separate but adjoining blocks[1] containing three replicates of 20 hills for each variety. The varieties were arranged so that no variety was planted alongside another more than once in each block. The arrangement of varieties in each of the two blocks, however, was identical. One of the two blocks was dusted with DDT, and the other left undusted. Three applications of a 3 per cent DDT dust were made at Urbana and four dustings with 5 per cent DDT were applied at Des Plaines. The block to be dusted was chosen with re-

[1]One problem in using DDT for which there seems to be no easy solution is the matter of drift (17) which largely precludes the possibility of setting up randomized blocks or Latin-Squares.

spect to the direction of prevailing winds so that a minimum of DDT would drift into the undusted block. No attempt was made to follow a predetermined schedule or to hold the number of applications within the limits of commercial practice, but rather to put on a number sufficient to obtain maximum leafhopper control.

Leafhopper nymphs were counted on one median leaf on each of five plants selected at random near the center of each plot. Counts were made at approximately seven-day intervals until within three weeks of harvest (Urbana) or until populations had diminished to insignificant numbers (Des Plaines). Flea beetles were never present in sufficient numbers to warrant taking population or feeding records. Severity of hopperburn was recorded several times during the season in both plantings. All plots were examined for the presence of virus and other diseases at approximately three-week intervals.

Harvesting of each variety was done within two or three weeks after vine maturation. The vines were considered mature when 90 per cent of the foliage was dead. All tubers measuring over 1 inch in diameter were counted to determine tuber set per hill. Specific gravity determinations were made on 10-pound samples taken at random from each block. The per cent of starch was calculated from the equation of Von Scheele *et al* (11). The pounds of starch per acre were obtained by multiplying pounds of tubers to the acre by per cent starch.

Weather Conditions

Weather at Urbana was extremely favorable for the growth of early-planted potatoes with the exception of the period between planting and emergence during which rainfall totaled 4.79 inches. Rainfall from emergence to harvest amounted to slightly more than 19 inches which was rather uniformly distributed throughout the growing season. The temperatures were normal for the season. Weather at Des Plaines was decidedly unfavorable for good growth of potatoes. Near-drought conditions prevailed with rainfall during the growing season totaling only 9.1 inches of which 6 inches fell on three days. The months of July, August and September were well below normal in rainfall and, as would be expected, above normal in sunshine. However, temperatures were only slightly above normal.

Results

Leafhopper Populations. Leafhopper nymphs increased in the undusted plots at Urbana (table 1) as the season progressed but declined at Des Plaines (table 2) These trends are found very often in early and late-planted potatoes in Illinois. Efforts to prevent leafhopper increases

TABLE 1.—*Leafhopper populations in relation to varieties, hopperburn and yield increases from control with DDT. Planted at Urbana on April 13—Average of 3 plots.*

Variety	Treatment[1]	Leafhopper Nymphs per Leaves June 16[2]	June 24	July 1	July 8	Mean	Hopper-burn[4]	Per cent Increase in Yield from DDT
Triumph	No DDT	28.7	24.7	58.3	72.3	46.0	Severe	203
	DDT		0	0	0		None	
Pontiac	No DDT	19.3	12.3	53.7	56.0	35.3	Severe	185
	DDT		0	0	0		None	
Cobbler	No DDT	7.3	11.3	57.3	58.7	33.7	Moderate	122
	DDT		0	0	0		None	
Early Ohio	No DDT	8.0	16.7	51.0	43.0	29.7	Severe	82
	DDT		0	0	0		None	
Red Warba	No DDT	10.0	10.7	33.7	48.0	25.6	Severe	71
	DDT		0	0	0		None	
Chippewa	No DDT	6.7	8.0	30.0	45.3	22.5	Moderate	107
	DDT		0	0	0		None	
Sequoia	No DDT	3.0	6.7	26.3	39.0	18.7	Mild	11
	DDT		0	0	0		None	
Pawnee	No DDT	4.0	6.0	20.3	39.7	17.5	Moderate	115
	DDT		0	0	0		None	
Mesaba	No DDT	1.3	3.7	17.0	34.3	14.1	Moderate	49
	DDT		0	0	0		None	
Erie	No DDT	2.7	6.7	19.7	20.0	9.7	Mild	6
	DDT		0	0	0		None	
Average	No DDT	9.1	10.7	36.7	45.6	3.7[3]		

[1]Dusting dates: June 18, 21 anl July 3. Heavy rainfall on June 18 and 19 was reason for short interval between applications 1 and 2.

[2]Pre-treatment count.

[3]Difference for significance between undusted at 5 per cent level.

[4]Classified as "none" if less than 5 per cent dead foliage, "mild" if between 6 and 25 per cent, "moderate" if between 26 and 50 and "severe" if over 50 per cent.

TABLE 2—*Leafhopper populations in relation to varieties, hopperburn and yield increases from control with DDT. Planted at Des Plaines on May 23—Average of 3 plots.*

Variety	Treatment[1]	Leafhopper Nymphs per Leaves				Mean	Hopper-burn[2]	Per cent Increase in Yield from DDT
		July 12	July 20	July 26	Aug. 2			
Pontiac	No DDT	81.7	86.0	65.7	26.7	65.0	Severe	179
	DDT	12.3	18.7	0.7	0	7.9	Moderate	
Kasota	No DDT	98.7	94.3	35.7	10.0	59.7	Severe	151
	DDT	7.0	13.7	0	0.3	5.2	Moderate	
Chippewa	No DDT	50.7	73.7	30.7	15.0	46.4	Moderate	159
	DDT	4.3	3.7	0	0	2.0	Mild	
Russet Rural	No DDT	57.0	57.0	35.7	19.0	44.0	Moderate	85
	DDT	4.7	3.0	0	0.3	2.0	Mild	
Katahdin	No DDT	45.3	60.0	38.7	31.0	43.7	Moderate	135
	DDT	7.0	7.3	0	0	3.5	Mild	
Teton	No DDT	63.3	58.3	29.7	18.3	42.4	Moderate	141
	DDT	9.0	7.3	0.3	0.3	4.2	Mild	
Sebago	No DDT	60.3	64.0	26.0	16.3	41.7	Severe	190
	DDT	4.3	10.0	0.3	0	3.7	Moderate	
Pawnee	No DDT	52.3	46.7	33.3	11.3	36.0	Moderate	243
	DDT	8.3	3.0	0	0.3	3.2	Mild	
Sequoia	No DDT	37.3	35.7	33.0	30.0	34.0	Mild	74
	DDT	16.0	2.0	0.3	0.7	4.7	None	
Menominee	No DDT	74.7	34.3	11.7	8.0	32.2	Moderate	113
	DDT	3.3	0.7	0	0	1.0	None	
Ontario	No DDT	50.3	40.3	17.7	13.0	30.3	Moderate	226
	DDT	1.3	0.7	0	0.3	0.6	Mild	
Average	No DDT	61.1	59.1	32.5	18.0	5.2[3]		

[1]Dusting dates: July 8, 22, August 5 and 30.
[2]Classified as "none" if less than 5 per cent dead foliage, "mild" if between 6 and 25 per cent, "moderate" if between 26 and 50 and "severe" if over 50 per cent.
[3]Difference for significance between undusted at 5 per cent level.

with DDT were highly successful at Urbana but not so at Des Plaines. Apparently adult leafhopper infestation and oviposition occurred in the latter planting before DDT was applied. As a result absolute control was never achieved despite thorough applications of DDT.

Leafhoppers, Hopperburn and Yield. There was in general high correlation among leafhopper populations, severity of hopperburn and yield increases from DDT. There were a few varieties, however, in which all three factors appeared to be rather poorly correlated, namely, Early Ohio, Pawnee, Red Warba and Mesaba in the early planting and Russet Rural, Sebago, Pawnee, and Ontario in the later planting. Since Early Ohio, Red Warba and Mesaba are earlier than the other varieties, they may have matured before leafhopper populations were large enough to cause serious yield reductions, as suggested by Sleesman and Bushnell (13). Russet Rural is known to be somewhat resistant to leafhopper injury and this may explain its relative lack of response to leafhopper control. Sebago appeared to be more susceptible to leafhopper injury than some of the other varieties carrying larger populations. Large increases from leafhopper control were obtained from Pawnee and Ontario but they carried only a low to moderate number of nymphs. These two varieties seemed to be highly susceptible to leafhopper feeding although their hopperburn ratings would not suggest this. The remainder of the varieties under the conditions of these tests fell into susceptibility classes as reported by other investigators with Triumph and Pontiac being very susceptible and Sequoia very resistant. Erie had the lowest populations and responded the least to leafhopper control of any variety in the early planting. Although length of season may have been a factor here, these data suggest that under Illinois conditions Erie may have some resistance to leafhoppers.

Length-of-season Increases. Increases in length of season from leafhopper control in the early planting were somewhat greater with the very early varieties than with the later-maturing kinds (table 3). Although it might appear that the prolongation of season for the early varieties was not reflected adequately in yield increases, the length-of-season increases were still less than for the later-maturing varieties. Where early potatoes must be harvested at a predetermined time to be placed on a favorable market, the increases in length of season from DDT indicate that artificial vine killing will be necessary. Revised dates of planting or dates for vine killing for varieties such as Red Warba, Triumph, Mesaba and Cobbler could be determined from these or similar data. Early frost in the later planting (table 4) prevented completion for the most part of length-of-season records.

TABLE 3—*Measurement of the response of* 10 *potato varieties to leafhopper control with DDT. Planted April* 13 *at Urbana—Average of* 3 *plots.*

Variety	Length of Season in Days			No. Tubers per Hill (1 + Inch in Diameter)			Yield in Bushels per Acre			Specific Gravity		Pounds of Starch per Acre		
	No DDT	No DDT	Inc.	No DDT	DDT	Per cent Increase	No DDT	DDT	Per cent Increase	No DDT	DDT	No DDT	DDT	Per cent Increase
Pontiac	110	125	15	4.7	9.0*	91	149	425*	185	1.0390	1.0570	501	2346	369
Triumph	100	120	20	6.1	9.8*	61	158	479*	203	1.0575	1.0655	891	3161	255
Cobbler	105	120	15	7.2	10.5*	46	218	483*	122	1.0676	1.0825	1491	4173	180
Chippewa	110	125	15	7.2	10.4	44	218	451*	107	1.0575	1.0690	1203	3193	165
Pawnee	105	120	15	6.4	9.8*	53	196	421*	115	1.0640	1.0715	1247	3082	147
Early Ohio	95	115	20	5.1	6.2	22	190	345*	82	1.0650	1.0730	1231	2567	108
Red Warba	90	110	20	9.4	10.4	11	244	419*	71	....a	1.0725	....	3117	...
Mesaba	95	110	15	9.0	10.4	15	280	418*	49	1.0695	1.0755	1982	3260	64
Sequoia	140	140	0	10.0	10.6	6	573	637	11	1.0900	1.0990	5432	6727	24
Erie	120	125	5	10.7	11.4	7	522	552	6	1.0770	1.0635b	4134	3511	...
Average	107	121	14	7.6	9.8	36	275	463	95	1.0652	1.0729	2012	3558	164
Difference for significance—odds of 19:1				3.3	1.2		39	70						

* Dusted significantly better than undusted at 5 per cent level.
a Sample lost. This variety not considered in specific gravity and starch per acre averages.
b Early blight infection in dusted plots late in season caused partial defoliation which may have reduced specific gravity.

TABLE 4.—*Measurement of the response of* 11 *potato varieties to leafhopper control with DDT. Planted May* 23 *at Des Plaines—Average of* 3 *plots*

Variety	Length of Season in Days**			No. Tubers per Hill (1 + Inch in Diameter)			Yield in Bushels per Acre			Specific Gravity		Pounds of Starch per Acre		
	No DDT	DDT	Inc.	No DDT	DDT	Per cent Increase	No DDT	DDT	Per cent Increase	No DDT	DDT	No DDT	DDT	Per cent Increase
Pawnee	105	115	10	2.8	4.9*	75	56	193*	243	1.0900	1.0950	531	1945	266
Ontario	120	...	..	2.5	3.7	48	43	139*	226	1.0945	1.1015	431	1518	252
Pontiac	110	120	10	3.3	4.7	42	80	222*	179	1.0870	1.0960	730	2264	210
Teton	120	...	..	4.0	6.4*	60	96	232*	141	1.0915	1.1060	933	2645	183
Chippewa	110	120	10	3.2	6.0*	87	79	205*	159	1.0915	1.0985	768	2163	182
Kasota	115	125	10	4.6	7.4*	61	99	249*	151	1.0895	1.0990	938	2629	180
Katahdin	120	...	..	3.2	4.2	31	102	240*	135	1.1080	1.1115	1187	2382	145
Menominee	...	...	..	4.1	5.3	29	105	223*	113	1.0960	1.1000	1071	2909	122
Russet Rural	120	...	..	3.4	4.3	26	113	210*	85	1.0970	1.1045	1166	2356	102
Sebago	125	...	..	3.5	5.2*	48	70	204*	190	1.1085	1.1160	819	1570	92
Sequoia	...	...	..	3.7	5.0	35	183	319*	74	1.0985	1.0985	1921	3349	74
Average	110	120	10	3.5	5.2	49	93	221	154	1.0956	1.1024	954	2339	164
Differences for significance—odds of 19:1				.7	.9		28	37						

*Dusted significantly better than undusted at 5 per cent level.
**Severe frost prevented completion of records for most varieties.

Tuber Set and Yield. Leafhopper control with DDT resulted in significant yield increases in all varieties (tables 3 and 4) with the exception of Erie and Sequoia at Urbana. Yet only four varieties at Urbana and five at Des Plaines gave significant increases in number of tubers set per hill. Since all tubers regardless of variety are set early in the season probably at very nearly the same time, increases in tuber numbers in these tests may be considered a measure of the growth response of the smaller-size tubers to leafhopper control. Therefore, yield increases in these nine varieties might be attributed to a gain in weight not only in the large but also in the small tubers. All other varieties with the possible exception of Red Warba and Mesaba probably owe yield increases from leafhopper control to weight increases principally in the larger-size tuber classes. Apparently Red Warba and Mesaba set a large number of tubers per hill regardless of extent of leafhopper damage.

Starch Increases. The increase in pounds of starch per acre is considered to be the best criterion for evaluating response to leafhopper control. This takes into account increases not only in yield but also in starch content both of which are functions of leafhopper feeding. Specific gravity increases from leafhopper control with DDT were considerably more uniform at Des Plaines than at Urbana. At Des Plaines above-normal sunshine was accompanied by high starch production. Thus starch-per-acre increases in this planting were perhaps less important in determining differential responses than they were at Urbana. Although Triumph is usually considered more susceptible to leafhopper injury than Pontiac, its total response to control in these tests was somewhat less than Pontiac. The explanation can be found in the specific gravity increase which was 46 per cent (from 1.0390 to 1.0570) for Pontiac and only 14 per cent (from 1.0575 to 1.0655) for Triumph.

From the standpoint of specific gravity and starch per acre, Cobbler among the early to mid-season varieties and Katahdin among the later kinds would appear to have been superior to all others. The performance of Katahdin was all the more remarkable in view of the very low tuber set which would favor high quality but not necessarily high yield.

Diseases. Early blight was not a significant factor in reducing quality and yield except where it developed late in the season in dusted Erie plots at Urbana. Approximately 20 per cent of the foliage on this variety was yellowed which may have accounted to a large extent for failure to obtain significant increases in quality and yield. Early-blight lesions were present only in trace amounts on the other varieties at Urbana and did not appear at all in the Des Plaines planting.

The only virus diseases found in the plots at both locations were mild mosaic and leafroll. Mild mosaic was present only in Pontiac with six per cent infection, a figure considered too low to have markedly influenced yields. Leafroll was detected early in the season in six of the ten varieties at Urbana. Leafroll at Des Plaines could not be diagnosed with any accuracy although it was known that certain of the varieties—the same stocks as those at Urbana—carried the virus.

The potential yields based on freedom from leafroll were calculated for each plot of the six contaminated varieties at Urbana using the equation of Kirkpatrick and Blodgett (8). Average yield increases ranged from 2 bushels per acre for Pontiac (0.8 per cent leafroll) to 15 bushels for Red Warba (11.7 per cent leafroll). This is equivalent to increases of 0.34 and 3.3 per cent, respectively. Other varieties with intermediate increases and leafroll content were Cobbler, Erie, Chippewa and Pawnee. A recalculation of the yield data in table 3 with these corrections showed no significant changes within varieties. However, between varieties, undusted Erie was nó longer significantly poorer than Sequoia, and there was no significant difference among Early Ohio, Triumph and Pontiac. Dusted Cobbler became significantly poorer than Erie although it was not poorer before adjustment.

Although yield decreases from leafroll in these tests were relatively small they are so because the leafroll content of the stocks was low. Comparisons based solely on yield among such varieties as Chippewa—very susceptible to leafroll—and Katahdin—moderately resistant—would appear to be misleading unless leafroll content is taken into consideration. Research is needed to determine the per cent infection above which yields in experimental plots need to be corrected for virus diseases. Only in this way can a higher degree of precision in measuring other factors be attained.

Summary

New potato varieties are difficult to evaluate for qualities other than leafhopper resistance if these insects are numerous. Perfect or near-perfect control of leafhoppers is necessary for comparative purposes before the extent of damage from these and other yield-depressing agents can be measured. Phytotoxicity from insecticides and fungicides, and damage from diseases in previous experiments on varietal response to leafhopper control were not subject to measurement or have not been reported. Very little emphasis has been placed in the past on starch content of the tubers in evaluating varieties for leafhopper susceptibility or on length-of-season increases resulting from the use of DDT.

Experiments were undertaken in 1946 to determine the effect of leafhopper control with DDT on length of season, quality and yield of seventeen new and old potato varieties. No fungicides were used. An attempt was made to eliminate or to evaluate other yield-depressing factors. Near-perfect leafhopper control was obtained in an early planting but control in a later planting was somewhat poorer. Previous reports show that leafhopper populations, severity of hopperburn, specific gravity and yield increases from leafhopper control are closely correlated. The present work tends to confirm this. Erie and Sequoia had the lowest populations and responded the least to DDT. Triumph, Pontiac, Pawnee, Sebago and Ontario appeared to be the most susceptible to leafhopper feeding. Length-of-season increases from leafhopper control were greatest in the very early varieties.

Yield increases due to leafhopper control were not always accompanied by corresponding increases in number of tubers set per hill. Increased yields in certain varieties seem to be due to an increase in size of all tubers; others to a gain in weight among larger-size tubers. Red Warba and Mesaba set a large number of tubers regardless of whether leafhoppers were controlled.

Triumph responded more to leafhopper control than Pontiac if measured in bushels per acre but responded less than Pontiac on the basis of starch per acre which takes into account both yield and specific gravity. From the standpoint of starch produced per acre, Cobbler in the early planting and Katahdin in the later planting were superior to all other varieties.

Early blight was not a factor in dusted plots of the Erie variety where reductions were found in both quality and yield. Leafroll was identified in varying amounts in six out of the ten varieties in the early planting. Leafroll content in these stocks was less than 12 per cent with resulting yield decreases of 3.3 per cent or less. The potentialities of virus diseases in experimental potato planting should not be overlooked.

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FERTILIZER AND CULTURAL EXPERIMENTS WITH POTATOES REPORTED DURING 1944-1946

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FERTILIZER EXPERIMENTS

Modern fertilizer experiments with potatoes do not deal only with the yield of tubers. Approaches to the problem vary widely, many studying some aspect of tuber quality.

In the three years, 1944 through 1946, five reports appeared relating soil tests to yield (46, 26, 14, 52, 56). Four dealt with the relation of fertilizers to chemical tests of the petiole or leaf tissue (25, 37, 54, 59). Incidentally, two others dealt with the method of making such tests (21, 44).

Three reports were concerned with the effect of fertilizers on cooking quality (18, 47, 48) and three with the specific gravity of the tubers (17, 34, 54). In Wisconsin the boron in soil and tubers was studied in relation to blackening of cooked potatoes (38). The problem of blackening has also been approached from several other angles (47, 48, 60, 63). Likewise, the studies on the ascorbic acid content of potatoes have been approached from the viewpoint of soil and climate rather than as effects of fertilizer alone (30, 42, 65). This is true also in the question of suitability of potatoes for dehydration (9, 10).

Reports on other of the less common minerals used as fertilizers include a detailed study on the use of sulfate of magnesia potash in New York (54) and a briefer paper from South Carolina (3). The effect of chlorine was reported from Minnesota (36). Colorado studied the effect of minor elements on yield and skin characteristics of Red McClure (39, 55).

Testing new carriers of standard fertilizer elements, Brown and coworkers reported on the value of ammonium nitrate (7) and of colloidal phosphate (8).

Three reports appeared on placement of fertilizers, mostly concerned with the possible advantages of applying part of the fertilizer before plowing or of distributing part on the plow sole (5, 11, 43). Along this line of thinking, Emmert (22) studied the time at which the growing plant critically needs nitrogen and potash nutrients. Ware and Johnson also reported on nitrogen requirement (64).

A report from Idaho summarized ten years of cooperative fertilizer tests (32). The requirements of acidic bracken soil were studied in Eng-

land. (16). In Virginia, Carolus (12) pointed out differences in the effect of fertilizers on yield of tops and of tubers. Wessels briefly summarized the Long Island experiments on soil acidity (67).

Other Soil Conditions

Some results from crop rotations were mentioned in five papers (6, 24, 61, 66, 68). The possibilities of improving soil structure by applications of lignin were explored in New Hampshire (19), and the effect of sawdust reported from Alabama (29). The effects of alkaline salts on the smoothness of skin and the shape of tubers was reported from Idaho (4, 31).

Cultural Treatments

Bulletins on growing the crop were published in Alaska (28), in Indiana (20) and in Missouri (69). Effects of planting conditions on stand and on yield were reported from Louisiana and from California (33, 35). An impressive bulletin on the size of seed piece came from Maine (15). The effect of date of planting and other practices were reported from Rhode Island (51).

Killing of tops by chemicals to facilitate harvesting or aid in control of diseases was studied in North Dakota and in Oregon (27, 45). Some effects of sprout retarding or sprout accelerating treatments were given in three investigations (23, 49, 71).

Studies Concerned with Physiology and Ecology of Growth

Some of the work on the physiology of the plant is of practical interest. Thus, for example, Bald (1) attempted to describe in technical terms the normal growth of potato foliage and later commented on the competition in the growth of tops and tubers (2). Wolf and Duggar (70) studied the physiological role of solanin in the plant; Sukhorukov (58) the role of copper; Street and co-workers the assimilation of ammonium and nitrate nitrogen (57). Cavanillas measured transpiration by means of lysimeters (13).

From an ecological viewpoint, length of day was studied by Rayner (50) and by Montemartini (40). Broad effects of climate were described in three other foreign papers (41, 53, 62).

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RESULTS OF SPRAYING AND DUSTING POTATOES IN NORTH DAKOTA FOR 1946 AND 1947

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PART I. EFFECT OF INSECTICIDES ON TUBER YIELD

The 1946 plots were at Grafton, North Dakota, and the 1947 plots near Grand Forks, North Dakota. The research was conducted cooperatively by the N.D.A.C. Experiment Station and the State Seed Department. The sixteen treatments were replicated six times, and arranged according to the triple lattice design.

Each of the ninety-six plots was two rows wide and eighty feet long with two untreated buffer rows on each side. The buffer rows permitted the development and build-up of insect populations and received some drift from adjacent insecticidal plots, especially with the dusts. The necessity for buffer rows was particularly shown in the 1946 plots. One-half of certain buffer rows, especially those adjacent to dust plots stood out very green whereas the other one-half of the row showed marked insect damage. Without the separation by buffer rows, the insecticides of low insect toxicity would have demonstrated better insect control than would have been warranted.

The sprays were applied at 400 pounds pressure by a tractor drawn, power take-off Bean sprayer. The dusts were applied by a tractor-mounted Niagara power duster. Applications of insecticides were made between 8:00 p. m. and 4:00 a. m. when there was no drift from wind. The tractor was driven through the check plots at the time of insecticide applications so that any wheel damage would be the same in all plots.

In the 1946 plots, 7 per cent Tribasic Copper Sulphate was added to each dust, with the exception of Velsicol 1068. Tribasic Copper Sulphate was added to each spray material at the rate of 4 pounds per 100 gallons of water. Fungicides were not incorporated with the insecticides in 1947, but all plots received one application of Dithane D-14 following the appearance of early blight, on the 19th of August.

In 1946 both U. S. No. 1 and the total yield data were obtained. The differences between the adjusted means of both yields obtained from the analysis of variance were uniformly constant for all plots.

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TABLE 1.—*Insecticidal treatments and tuber yields*: 1946, *Grafton, North Dakota*

Plot	Treatment	Rates of Application	Dates Applied	Total Yields (Bu. per Acre)
	Sprays Applied at 125 Gal. per Acre	Amount of Insecticide per 100 Gal. Water		
1S	Syndeet 25 per cent DDT emulsion	¼ lb. DDT	July 14, 27 & Aug. 10, 24	131
2S	DDD 25 per cent emulsion	¼ lb. DDT	"	152*
3S	Hexachlorocyclo-hexane (666) 50 per cent powder	½ lb. 666	"	148
4S	DDT 50 per cent powder	¼ lb. DDT	"	146
5S	DDT 50 per cent powder	½ lb. DDT	"	170**
6S	DDT 25 per cent emulsion	¼ lb. DDT	"	155*
	Dusts	Pounds per Acre		
7D	DDT 5 per cent	35 lbs.	July 13, 27 & Aug. 9, 23	145
8D	DDT 3 per cent	35 lbs.	"	173**
9D	DDT 5 per cent	35 lbs.	July 13, 27 & Aug. 9	157*
10D	DDT 5 per cent	35 lbs.	July 13, 27	144
11D	DDT 5 per cent	35 lbs.	July 13	132
12D	DDT 5 per cent	35 lbs.	July 27 & Aug. 9, 23	153*
13D	DDT 5 per cent	35 lbs.	July 13, 18, 27 & Aug. 3, 9, 16, 23, 30	153*
14D	DDT 5 per cent	35 lbs.	July 13, Aug. 9	151*
15D	Velsicol 1068 5 per cent	35 lbs.	July 13, 27 & Aug. 9, 23	144
16	Check—no treatment			126

*Indicates significant difference at 5 per cent level as compared with Check Plot No. 16.

**Indicates highly significant difference at 1 per cent level as compared with Check Plot No. 16.

Least significant difference between any two adjusted means at the 5 per cent level = 24.86 bu. per acre; at the 1 per cent level = 35.71 bu. per acre.

Insecticides donated by:	Plot Number
United States Rubber Company, New York 20, N. Y.	1S
Rohm and Haas Company, Philadelphia 5, Pennsylvania	2S
E. I. DuPont de Nemours & Company, Wilmington 98, Delaware	3S, 4S, 5S, 6S
Agricultural Supply Company, Grand Forks, North Dakota	7D, 8D, 9D, 10D, 11D, 12D, 13D, 14D
Velsicol Corporation, Chicago, Illinois	15D

TABLE 2.—*Insecticidal treatments and tuber yields*: 1947, *Grand Forks, North Dakota*

Plot	Treatment—July 2, 15, 29 and August 12, 25	Adjusted Mean Yield Bushels per Acre
Dusts: Applied at 20 pounds per acre.		
1D	DDT 5 per cent	259.0
2D	DDT 3 per cent	260.7
3D	DDD 3 per cent	263.4
5D	DDD 3 per cent and HE 761 2 per cent	273.6**
6D	Piperonyl Butoxide 1.25 per cent	254.4
7D	Piperonyl Cyclohexanone .625 per cent	258.6
8D	Benzene Hexachloride (1 per cent gamma isomer)	245.6
9D	Chlordane 5 per cent	260.0
10D	Aryl Alkyl Thionophosphate 1 per cent	258.9
Sprays: Applied at 100 gallons per acre; 1 pound actual lethal ingredient (such as DDT, etc.) per 100 gallons of water.		
4S	Toxaphene (a Chlorinated Camphene)	248.1
11S	DDT 50 per cent Wettable Powder	264.6*
12S	DDT 25 per cent Emulsion	258.6
13S	Hexaethyl Tetraphosphate 9 per cent; other Phosphates 16 per cent	259.2
14S	Benzene Hexachloride 50 per cent Wettable Powder	250.9
15S	Methoxy Chloro Composition 50 per cent Wettable Powder	259.8
16	Check—no treatment	239.9

*Indicates significant difference at 5 per cent level as compared with Check Plot No. 16.

**Indicates highly significant difference at 1 per cent level as compared with Check Plot No. 16.

Least significant difference between any two adjusted means at the 5 per cent level = 24.62 bu. per acre; at the 1 per cent level = 32.74 bu. per acre.

Insecticides donated by:	Plot Number
Agricultural Supply Company, Grand Forks, North Dakota	1D, 2D, 8D
American Cyanamid & Chemical Corporation, New York, N. Y.	10D
California Spray & Chemical Corporation, Richmond, Calif.	13S
Dodge & Olcott Company, New York, N. Y.	6D, 7D
E. I. DuPont de Nemours Company, Wilmington, Delaware	11S, 12S, 14S, 15S
Hercules Powder Company, Wilmington, Delaware	4S
Rohm & Haas Company, Philadelphia, Pennsylvania	3D, 5D
Velsicol Corporation, Chicago, Illinois	9D

Therefore, only the total yields were taken in 1947. The treatments applied and the adjusted mean yields for 1946 and 1947 are listed in tables 1 and 2, respectively.

Results

Two treatments showed significant yield increase when compared with Check Plot No. 16 receiving no treatment. Plot No. 11S (DDT 50 per cent wettable powder) was significant at the 5 per cent level and Plot No. 5D (DDD 3 per cent and HE 761 2 per cent) was highly significant at the 1 per cent level.

The yields for 1947 in general, compared with the results in 1946. DDT 3 per cent dusts again yielded more than DDT 5 per cent dusts although only 1.7 bushels per acre as compared with 28 bushels for 1946.

The combination DDD 3 per cent and HE 761 2 per cent dusts was highly significant at the 1 per cent level and the highest yielding plot. This combination was not available in 1946 when DDD alone gave significant results at the 5 per cent level.

The fluctuations of increased yields cannot be explained by comparable reductions of insect populations. A summary of the insect abundance and tuber yields for the insecticidal plots of 1946 and 1947 will follow in Part II.

Part II. Insect Abundance and Tuber Yield

The results of the 1946 and 1947 North Dakota experiments show that there is no true correlation between insect abundance and tuber yield. The close similarity of actual total yield and the adjusted total yield for the 1946 plots at Grafton and the 1947 plots at Grand Forks indicate a great uniformity of soil and stand. At most, the difference between actual total yield and the adjusted yield was less than two bushels per acre, except for the check plot in 1947. Hence, any differences in yields would be due to insects or the effect of the insecticides on the plants.

In 1938 Munro and Schifino[1] indicated that the increases in tuber yields could not be explained by a comparable reduction of flea beetle injury as determined by an actual count of flea beetle holes in the leaves.

Since there was no true correlation between insect abundance and yields in 1946, it was decided to use the actual damage (leaf holes) of the flea beetle, instead of insects collected by sweeping as a better criterion for correlating damage and yield. Table 3 lists the total insects or damage on the plots for 1946 and 1947, in addition to tuber yield.

In the 1946 plots 12 and 13 yielded alike. Plot 12 had forty-two times as many Colorado potato beetles, four times as many flea beetles

TABLE 3.—*Total insect population and tuber yield*

1946 INSECTICIDAL PLOTS AT GRAFTON, NORTH DAKOTA. (Counts made July 26, August 6, 19 and September 7.)

	Plot Numbers							
	1	2	3	4	5	6	7	8
A	11	24	43	12	22	10	11	12
B	1327	2050	1886	1526	594	1636	1474	2277
C	177	285	374	203	118	223	189	227
D	109	159	199	146	121	135	149	142
Y	131	152*	148	146	170**	155*	145	173**

	Plot Numbers							
	9	10	11	12	13	14	15	16
A	3	7	18	168	4	12	3	205
B	1446	2222	2903	1781	438	2209	2051	3179
C	196	253	269	219	104	210	291	274
D	134	135	115	142	107	131	165	130
Y	157	144	132	153*	153*	151*	144	126

1947 INSECTICIDAL PLOTS AT GRAND FORKS, NORTH DAKOTA. (Counts made July 9, 15, 21, 29; August 5, 12, 20, and September 3.)

	Plot Numbers							
	1	2	3	4	5	6	7	8
A	89	37	177	35	290	302	183	102
B	17514	16243	18511	18914	18183	17748	16769	17234
C	213	192	199	204	244	231	255	352
D	413	393	348	321	275	312	283	364
Y	259.0	260.7	263.4	248.1	273.6**	254.4	258.6	245.6

	Plot Numbers							
	9	10	11	12	13	14	15	16
A	28	304	14	32	192	102	16	437
B	19794	15417	14272	15490	15342	17388	13764	25769
C	307	200	119	110	198	254	126	234
D	414	306	303	252	294	285	208	516
Y	260.0	258.9	264.6*	258.6	259.2	250.9	259.8	239.9

A—Adults and larvae Colorado potato beetle
B—Adult potato flea beetles (1946). Adult potato flea beetle injury (leaf holes) 1947.
C—Adults and nymphs potato leafhoppers
D—Adult six-spotted leafhoppers
Y—Adjusted mean yield bushels per acre
*—Significant at 5 per cent level as compared with Plot 16 receiving no treatment
**—Highly significant at 1 per cent level as compared with Plot 16 receiving no treatment.

and twice as many potato leafhoppers as Plot 13. Plot 12 received only three applications of a 5 per cent DDT dust, whereas plot 13 received eight applications of the same.

Plot 8 receiving four applications of 3 per cent DDT dust was highly significant at the 1 per cent level and the highest yielding plot. However, plot 8 had the third highest population of flea beetles and was above the average for the three other insects. Plot 5 receiving four applications of DDT spray was the only other plot showing high yield significance at the 1 per cent level and had approximately one-quarter the number of flea beetles and half the number of leafhoppers of plot 8.

In the 1947 results, plot 5 (DDD 3 per cent and HE 761 2 per cent) was the fifth highest in flea beetle injury, yet it was the only yield showing high significance. Plot 15 (Methoxy Chloro Composition) with the lowest flea beetle injury and among the lowest in other species of insects did not have a significant yield and was sixth in tuber yield.

In order to account for these differences in yield, further research must be done to determine the possible stimulating or depressing effect caused to plants by the newer insecticides.

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REPORT OF FIELD MEETING — POTATO ASSOCIATION OF AMERICA

Aroostook Farm, Presque Isle, Maine

August 19 - 20, 1948

The meeting was called to order by Verne Beverly, County Agricultural Agent, who introduced Dr. Fred Griffee. Mr. Beverly was instrumental in making all the preliminary arrangements. Dr. Griffee extended greetings for the members of the Experiment Station staff who were present at the time. There were about 60 people from the United States and Canada. Later, this number was increased to 80.

A mimeographed sheet was furnished to each one present, giving in detail something about the potato research work that was being carried on at the farm. In addition, to this material, copies of the program and a circular regarding the new potato house were made available.

President Newdick outlined the purpose of the conference, indicating (1) that it was to be a serious meeting; (2) that there would be

no opportunity for play; and (3) the value of the meeting would depend upon the individual, because a selection would have to be made to get that which one desires most.

At 10 A. M. the group visited the fields, and, under the guidance of Dr. Bonde not only visited the aphid control experiments, but also some virus-disease work by Dr. Schultz as well as some fertilizer and organic experiments by Dr. Terman.

After lunch the field studies were resumed. Dr. Folsom then gave an outline of the work in which temperature controlled bins had been used. The result of storage on net necrosis and stem-end browning was explained.

Following this a demonstration on the use of the flame thrower for killing tops was held. The disease service plots were then visited and symptoms of some of the virus diseases explained in detail. This was particularly for the benefit of many of the certified officials and inspectors. We next moved to the ring-rot plot below the track and at this point Dr. Bonde discussed his work with resistant varieties.

The day's program was rounded out by Mr. Lombard who showed us some of his most recent work in row and tuber-spacing occasioned by the introduction of the Kennebec variety.

Robert Akeley, of the U.S.D.A., showed us some very promising seedlings and dug some tubers so that a study could be made. This completed the field work for that day.

In the evening a banquet was held at the Northeastland Hotel, with President Newdick presiding. Although the evening was very warm, it was a most enjoyable one for the 110 members and guests who were present. As usual, all the visiting officials of the Association were introduced. The main address of the evening was given by A. K. Gardner, Commissioner of Agriculture of the State of Maine. This was followed by the presentation of a colored film entitled "As Maine Grows". The picture was shown by Mr. Bryce Jordan, Manager of the Seed Department of the Maine Potato Growers, Inc. The making of this picture was financed by this organization and they deserve a lot of credit for making available to the Industry what, to me, is the best picture I have ever seen showing the production of certified seed. Enough talent was available for an extended program but on account of the strenuous day and the rather warm evening, it was decided to adjourn early.

Friday morning, August 20th, the group gathered again at Aroostook Farm. Pilot Soucy, who was flying over in a helicopter, yielded

to our signals and landed for a short stop to explain something about his experiment. All were grateful to him for his "flying visit."

Dr. Stevenson and Mr. Akeley took some of the visitors to the Chapman Farm where several acres of extensive breeding work are being conducted. The writer did not attend this session. Those who did attend praised it highly. Many of them also visited the spraying work on the Kempton Farm.

Those interested in diseases, and who remained at Aroostook Farm, spent some time in the greenhouse where Drs. Schultz, Bonde and Dr. MacLeod gave a clear-cut explanation of purple top, particularly stressing symptoms and results.

At this point we again visited the disease plots. A field discussion period was held regarding black leg, after which the meeting resolved itself into a question and answer period. Before departing we visited the top-killing plot with a talk by Paul Eastman of the station staff.

At 12:30 it was decided to adjourn officially and permit each individual to select his own program for the afternoon. Many returned to the Station for further discussion with the staff members regarding specific problems. A small group was accompanied on a tour around the country.

In conclusion, let me say that all of us are very grateful to Mr. Keenan and Mr. Scannel of the Dominion Department of Agriculture at Ottawa for the results of their efforts in attracting such a fine attendance at the meeting. There were 45 members present from the various Provinces. I sincerely hope they felt their time was well spent. Your President was very frank in telling every one that if he failed to get information from the Aroostook Farm meetings it was his own fault.

Respectfully submitted,

E. L. NEWDICK, *President.*
Potato Association of America.

SECTIONAL NOTES

INDIANA

Our commercial potato harvest has started in full swing. We have ideal weather for getting the potatoes out of the ground and the yield and quality are exceptionally good this year. We will have quite a few growers who will exceed more than 400 bushels of No. 1's to the acre,

not overly large, and a still higher percentage of No. 1's than we have ever had before.

Our growers kept spraying and dusting to control the diseases and insects and find that these late control measures are the most profitable ones to apply. The potatoes are moving to the market in 10 and 25-pound sacks and the consumers are well satisfied with these family-size packages. The Indiana potatoes in our state are out-selling all other sources four to one.—W. B. WARD.

NEBRASKA

Notes from Nebraska have been neglected for some time, so a little in recapitulation should be in order. Growers, remembering rainy periods in mid-June in previous years, began planting about the 1st of June, two weeks earlier than usual. The rainy period from the 15th to the 25th of June then held up planting until the latter part of the month. Nebraska growers, therefore, have an early and a late-planted main crop.

The early plantings grew rapidly through a cool July and early August. About the 10th of August there was a sudden change. Whereas, temperatures had been below normal, the other extreme became the rule, with day after day temperatures in the high 90's or over 100°.

The result on the dry land crop has been to fire severely or to mature the plants. In many fields, because of the early growth, there was already a good set, and possibly an average yield had almost materialized. During the same time, the growers who used irrigation, had difficulty holding their crops because of this heat, which caused excessive evaporation. It is difficult at this time to evaluate the result of these extremes on the crop, though it is apparent that a better crop is in prospect than was the case in 1947 when we had a short crop.

The first general rain in almost a month is falling at this time. What the outcome may be is problematical. We think that the early fields will not be revived. Some other fields, however, may resume growth, resulting in poor type. Early Blight infection, which usually occurs about this time of the year, may be suddenly built up and become a serious factor, providing the rains are followed by fog and high humidity for a few days.

The early crop in central and eastern Nebraska is practically cleaned up at this time. This crop, which started off with a number of difficulties in the spring, was favored by the good conditions in mid-summer, and excellent yields were the general rule. Many fields of Red Warba potatoes yielded 300 sacks of No. 1 grade. In general, the prices were at or above support levels. In the past two or three weeks

this has sagged somewhat, and the Government has been purchasing many of the potatoes being harvested.

At this time, the interest in the Government support is still not too strong. Last year there was practically no sign-up in the late crop. However, the indications are that many more growers are taking advantage of the program offered by the Government this season.

The Government, in cooperation with the State College of Agriculture and local interests, ran an interesting experiment about a month ago on the potatoes harvested in central Nebraska. Some of the surplus purchased by the Government was sliced up and spread on the runways of an air strip for natural dehydration. The product that resulted is being tested in feeding experiments at the University of Nebraska this fall and winter. Members of both the potato and cattle industry are watching this with interest.

The acreage of potatoes entered for certification in Nebraska is approximately 20 per cent less than in 1947. This is a continuation of the trend established three years ago; to a lesser degree this reduction in acreage is also true of commercial or non-certified plantings.

The reasons for the reduction in acreage planted to potatoes is first the competition offered by other crops that are much more easily grown. The crop which is most favorable under dry land conditions is winter wheat, which can be grown with a minimum of labor, and which, of course, has been producing high yields at high prices. Under irrigated conditions the crop which is replacing potatoes is largely beans of the dry, edible type. The ease of growing and harvesting in the case of beans, in addition to the extremely high prices, has made it a strong competitor of potatoes.

In addition to the crop competition, we have had a disparity of prices for the past year or two. Certified seed growers have not received the high premiums that existed for many years and during the past year many certified seed potatoes were diverted to table stock channels. This was caused by the fact that table stock out of this territory sold on the market at extremely high prices. In previous years the competition of certified potatoes was from certified seed in other states, but during the past season especially, this competition was primarily local-grown table stock.—Marx Koehnke.

New York

Growers who took care of their crop will harvest their biggest yield in years. Cobblers and Chippewas now being dug are reported at 500 bushels and more per acre. However, in poorly-cared-for fields

blight is taking its toll and this will reduce the average for the state but it still will probably be the highest on record.

The certified seed crop is showing fine promise. Disease counts have been low and insects have been well controlled. A campaign for close planting to keep size down has been a big help this year in keeping the tubers within seed size tolerance.

Markets are more or less demoralized. Many growers under the Support Program will utilize its facilities, but the general market is about 25 cents under support. Potatoes from out of state form one of the chief competitive factors.

Many of our growers are using a 2¼" and some 2½" screen to insure more uniform sized packages. Seed growers, especially, will use these screens to take off the larger sizes for market, saving the smaller sizes for certified seed. This size, coupled with high quality and an apparent desire to give the public better potatoes, ought to help move the crop to local markets.

The potato vines show vigorous growth but the set is not in keeping in many fields. Many growers consider the government estimate of yield too high. Our growers may still have to contend with dry or wet weather, frost and blight.

Fields under certification are showing a remarkable freedom from virus diseases, reflecting their program to develop the best Foundation stock. Our growers have planted their potatoes closer in order to keep the size down.—H. J. EVANS.

OREGON

The use of improved seed is having its effect in reducing the disease content of the Klamath potato crop. Our second field inspection was completed with a much higher percentage of the crop entered meeting certification requirements. It was particularly noticeable that much seed of local origin which was planted this year met certification requirements. This is a particularly healthy development.

A meeting of potato growers is scheduled for the 1st of September in order that all growers from this entire district might consider regulations to be put into effect under the Potato Marketing Agreement. Organization of an area committee was completed about two months ago. Approximately 85 to 90 per cent of the potatoes in the area are eligible for potato support.

In general, the crop is very promising and with frost-free weather continuing, improved yields and quality should result. The acreage, however, is only slightly above that of last year.—C. A. HENDERSON.

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Vermont

The 1948 acreage of potatoes in Vermont is well down to an all time low, approximately 7,000. During the time, however, that a great many farmers have dropped out of potatoes entirely, there has been a marked development in specialized potato growing. Acreages varying from 50 to 100 are fairly common among commercial growers and most of these growers have not only good storage houses but also up-to-date equipment.

All indications point to a good yield. Some late blight started in mid-August, but the extremely hot spell late in the month apparently dried it up. Little early blight and no ring rot had been reported to date. Black leg was rather common, and the virus diseases appeared to be slight.

Only 457 acres were entered for certification, most of which has passed field inspection. Our varietal break-down is as follows: Green Mountains, 221 ⅔; Katahdins, 182¼; Houmas, 50; Russets, ⅕; and Others 3.

Top-burning was effectively demonstrated at the Fred W. Peaslee farm in Guildhall on the last day of August when the Seed Potato Growers' Association held its annual meeting there. Several growers are using this means of solving the heavy vine problem during their harvesting operations.

Insects, with some exception regarding aphids, have become practically *nil* in the potato fields of Vermont with the advent of DDT. It is now nearly 100 per cent in general use.—Harold L. Bailey.

Manitoba

During the past 15 days our growing conditions have been ideal. Manitoba is expecting one of its greatest vegetable crops in the last 15 years. The market is being glutted practically for every variety of vegetable.

The potatoes in certain sections of the province are heavily infested with late blight and due to the lateness of the season the growers are not able to control this spread and at present it appears that the crop will be lower by at least 50 per cent due to the infestation of the disease.

The seed potatoes are doing wonderfully well and the seed growers seem to be more successful in controlling late blight.

We are anticipating a heavy yield especially of the Cobbler and Green Mountain varieties.—H. Wasylyk.

Province of Ontario

Continued hot, dry weather in many sections of the Province has interferred with the development of the late potato crop, resulting in lower yields than was anticipated a few weeks ago. The quantity of marketable tubers as Canada No. 1 grade will be further reduced in some areas by scab and blight diseases. The maturity is reported as satisfactory and the cooking quality better than normal.

Several growers have rushed digging in order to seed their fields to winter wheat or rye, thus taking advantage of the period between grain harvesting and other fall work to market a percentage of their potato crops before any loss from disease, These factors account for the large amounts of potatoes reaching the markets. From the buyers' angle, demands have not been too brisk, due to some reduction in consumption because of hot weather, the holiday season, and the fact that it is yet too early to buy for winter storage. The general opinion is expressed that market prices for high quality potatoes will substantially improve as the season progresses.

Trading is reported as steady on Toronto Market (Sept. 9) with wholesale prices to retail trade for Canada No. 1 grade potatoes at $1.35 to $1.40 per 75 pound bag. Consumer demands favor a premium for pre-packaged and basket quantities.

More than 300 potato growers are members of seventeen 500-bushel per acre clubs this year, organized by county and district branches of the Ontario Crop Improvement Association. Yield lists will be estimated and quality scores made during the next few weeks. There is much interest in these contests.

The survey for bacterial ring rot disease is underway as a free service to potato growers. Only a few cases have been located to date, and these have been trace infections.

Several inquiries from export buyers have already been received for seed.—R. E. Goodin.

Ottawa Section Canada

The first field inspection of potatoes in Canada for certification purposes was completed approximately by the 1st of August. All districts report that a high percentage of fields passed this inspection. Apparently there has been a very low percentage of disease this year, and insects are also very scarce.

At the time of writing our second inspection is drawing to a close, and most areas still report a high percentage of fields passing as Foundation and Foundation A stock. Late blight is present is most areas,

but so far where fields have been sprayed and dusted it has not reached serious proportions.

The indications are that there will be a good yield, and in some parts of New Brunswick top-killing operations have been carried out to prevent the tubers from becoming too large.—J. W. SCANNELL.

ANNUAL MEETING, POTATO ASSOCIATION OF AMERICA DECEMBER 6-7-8. PITTSBURGH, PENNSYLVANIA

The annual meeting of the Potato Association of America will be held in Pittsburg December 6-7-8. We will hold a joint meeting with the American Phytopathological Society, Wednesday afternoon, December 8.

We want to make this an outstanding meeting since it will be our 25th anniversary. We need approximately fifty papers on all phases of the potato industry, in order to prepare an outstanding program. All persons desiring to present a paper at these meetings should submit titles and abstracts to John C. Campbell, N. J. Agricultural Experiment Station, New Brunswick, New Jersey, not later than November 1. Those desiring to present papers at the joint meeting with Phytopath must submit titles by October 20.

HEADQUARTERS FOR ANNUAL MEETING

The Fort Pitt Hotel has been chosen as the headquarters for the annual meeting of the Potato Association of America. Rates will be $3.75 to $5.00, single room, with bath; $5.50 to $7.00 double bed, with bath; and $7.00 to $8.00 twin beds, with bath.

Secure room reservations *now* by writing directly to the hotel.

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KENNEBEC: A NEW POTATO VARIETY RESISTANT TO LATE BLIGHT, MILD MOSAIC, AND NET NECROSIS

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Late blight, caused by *Phytophthora infestans,* is so common in the sections of the United States best suited for potato culture and causes such heavy losses that it is often referred to as "the potato disease".

It is true that this disease can be controlled to a large extent by careful spraying with certain fungicides. However, despite the facts that control measures are being practiced more generally than ever, that spray equipment has been improved, and that spray programs have been more faithfully carried out, large losses continue to occur. In some seasons and in certain sections the disease causes very little damage, but all too frequently the loss amounts to millions of bushels. Epidemics occurred in the United States in 1927, 1928,

[1]Horticulturist.
[2]Principal Geneticist.
[3]Principal Pathologist.

1932, 1936, 1938, and 1943. The loss in 1928 was estimated at 31 million bushels; in 1932, at 9,230,000 bushels, of which 9,058,000 bushels were lost in Maine. A blight-resistant variety would greatly reduce such losses and eliminate a large part of the cost of control measures.

Breeding for resistance to late blight in the potato began in the United States nearly 100 years ago. A relatively large number of varieties were produced. Some of them are grown commercially to the present day and have been noted for their high yields and good cooking quality but none of them showed any resistance to late blight. Breeding for resistance to this disease seemed to have been abandoned during the latter part of the nineteenth century, and methods of controlling blight by spraying with fungicides (mostly bordeaux mixture) were developed.

The breeding mode of attack was not again emphasized in the United States until potato breeding was actively undertaken by the United States Department of Agriculture in 1910. According to Clark *et al*[1]. the only disease resistance sought at the time was to the late blight fungus. This work had not progressed very far, however, when it became evident that the virus diseases had to be given the chief consideration, and it was not until the present National Potato-Breeding Program was under way that emphasis could be placed once more on breeding for resistance to late blight. The first indication of resistance observed in the present program was found in a cross of the two susceptible varieties, Chippewa and Katahdin. This cross was tested in 1932 for blight resistance in the field. Many of the seedlings were very susceptible, a few were intermediate in their reaction, but none of them showed the highest type of resistance. One of the best of these was eventually named Sebago and distributed to growers. The program continued with crosses in which intermediate types were involved such as President, Ackersegen, and Sebago. Many of the resulting intermediate types could be considered commercially resistant, but none of the selections was found superior in other characters to Sebago, which was already in commercial production. Most of them were too late maturing to be of value. However, Calrose, which shows an intermediate resistance to late blight, was produced from a cross of Ackersegen x Katahdin. This variety is being grown to a limited extent in California.

[1]Clark, C. F., and Stevenson, F. J. 1935. The Katahdin, Chippewa, and Golden Potatoes. U. S. Dept. Agr. Circ. 374.

The next step in advance was the introducing of the German *W* races. Seeds of these were obtained from K. O. Müller, Berlin-Dahlem, Germany. Seedlings grown from this material were tested in the field at Presque Isle, Maine in 1934, 1935, and 1936. Many of them did not become infected with late blight, although Green Mountain and other susceptible varieties were practically killed by the disease 30 to 40 days before they had time to mature. The seedlings related to the *W* races contributed two characters of great importance to the breeding program: much higher type of resistance to late blight than that found in President and in the other intermediates, and genes for early maturity. However, none of them approached the commercial varieties in yield or market quality. A few of the best of them were crossed with Earlaine, Katahdin, and Seedling 336-18. Selections from cross number 96 (German No. 3895-13 x Erlaine) were among the best of this series of crosses. Of these, 96-44 and 96-56 are highly resistant, if not immune to the common races of blight in Maine and are early and self-fertile. These two approached early commercial varieties in yield and cooking quality but they were inferior in yield to such standard varieties as Green Mountain, Chippewa, and Katahdin. Another series of crosses were then made using as parents the best selections from cross No. 96 and some of the highest-yielding varieties and seedlings available. From this second series B 70-5 was obtained. It was a selection from the cross B 127 x 96-56. B 127 was a Beltsville selection from a cross of Chippewa x Katahdin and at one time was considered for distribution to growers in Maryland. Seedling 96-56, from the cross German No. 3895-13 x Earlaine, was one of the first seedlings produced by the United States Department of Agriculture that combined blight resistance in both vines and tubers with mild mosaic resistance and early maturity.

During the winter of 1940, cross No. B 70 was made in the greenhouses of the Plant Industry Station, Beltsville, Maryland. The seedlings were grown in the same greenhouses in the fall of 1940 and the tubers sent to Presque Isle, Maine, for increase in 1941. A number of selections were made and since that time they have been tested for horticultural characters and reactions to various diseases. B 70-5 has proved to be the best of this group, although several others were close competitors.

The pedigree of B 70-5 follows:

Kennebec	96-56	Earlaine
U.S.D.A. Seedling No. B 70-5		3895-13
	B 127	Katahdin
		Chippewa

DESCRIPTION

Kennebec

Plants—Large, spreading; stems thick, prominently angled; nodes slightly swollen, green; internodes green; wings slightly waved, green; stipules large, green, and scantily pubescent; leaves long, broad, close, and dark green; midribs green and scantily pubescent; primary leaflets ovate, large, four pairs, mean length 64.70 ± 0.38 mm. (2.55 inches), mean width 38.27 ± 0.44 mm. (1.51 inches), index 59.32 ± 0.49[2]; petioles green; secondary leaflets many, between primary leaflets; tertiary leaflets few to none; inflorescence medium to little branched; leafy bracts none; peduncles medium long, green, and scantily pubescent; pedicels medium to long, green, and scantily pubescent.

Flowers—Calyx-lobe tips long, green, and scantily pubescent; corolla medium in size (32 to 34 mm. diameter), white; anthers orange yellow; pollen abundant, good quality; style straight; stigma globose, multilobed, green.

Tubers—Elliptical to oblong, mean length 90.04 ± 0.56 mm. (3.54 inches)[3]; mean width 72.22 ± 0.24 mm. (2.84 inches)[3]; mean thickness 57.68 ± 0.35 mm. (2.27 inches)[3]; index of width to length, 80.59 ± 0.74[4]; of thickness to width, 80.10 ± 0.67[5]; of thickness to length, 64.49 ± 0.70[5]; skin smooth, self-colored, creamy buff; eyes shallow, of

[2]Calculated by dividing the width of each of 100 leaflets by the length and multiplying the average of these ratios by 100. The leaflets were taken from the fourth leaf from the top of a stem, one leaflet, the distal left lateral, being taken from each leaf. Since the potato leaflet is asymmetrical the length was determined by taking the average of the measurements from the apex to the base of each respective lobe. This is a modification of the method described in Salaman, R. N.: *Potato Varieties*, pp. 163-170. Cambridge, 1926.

[3]Average of measurements of 100 tubers each weighing approximately 8 ounces (223-233 gm.).

[4]Calculated by dividing the width of each of one hundred tubers by the length and multiplying the average of these ratios by 100. The data used for calculating the index were taken from the same measurements as those used to designate the dimensions of the tubers.

[5]Based on the measurements of the same tubers as those used for determining the width-to-length index, using the same methods of calculation.

same color as skin; eyebrows medium long, curved, medium prominent; flesh white; sprouts creamy white when developed in the dark; maturity late.

CHARACTERISTICS

Kennebec is a vigorous, fast-growing, high-yielding, late-maturing variety. In tests for 5 years at Presque Isle, Maine, it outyielded Green Mountain by an average of 19 bushels of U. S. No. 1 potatoes per acre. In the same tests it outyielded Katahdin by 97 bushels per acre, Chippewa by 41, and Sebago by 79. It produced also the highest percentage of U. S. No. 1 tubers as shown in table 1.

The specific gravity data for these tests show in table 2 that B 70-5 does not have as high dry-matter content as Green Mountain but has averaged higher than Katahdin, Chippewa, or Sebago. It has been judged as very good to excellent for either baking or boiling by a relatively large number of people who have tested it for cooking quality.

In 1946 and 1947 tests were made of Kennebec in comparison with standard varieties at several places in Maine. The data for these tests are given in tables 3 and 4. Both the specific gravities and the yields of all varieties varied from place to place in both years. In 1946 all varieties were mealy as grown at Presque Isle, but none of those grown at Fort Kent would be in that class. On the other hand, the yields at Fort Kent far exceeded those of the plots at Presque Isle. In 1947 the specific gravity readings were comparatively low for all tests. Kennebec exceeded Green Mountain in average yield in five tests in 1946 and in four tests in 1947; however, Green Mountain was slightly higher in specific gravity than Kennebec.

The resistance of Kennebec to the common races of late blight is very high in both foliage and tubers. Under field conditions in the late blight test, where the vines were inoculated or sprayed with zoospores and where no commercial fungicides were used, the Kennebec variety has shown no late blight lesions for several years. The tubers, when harvested at an immature stage and sprayed with zoospores, showed a trace of late blight rot after a 2-week incubation period, as did the Sebago tubers also. In this test the tubers of the susceptible seedlings and Green Mountain checks were severely affected. In the 1946 yield test at Dover-Foxcroft, Maine, there was considerable blight rot in the tubers of susceptible varieties with large differences between the varieties. Sequoia showed approximately 38 per cent tuber rot; Green Mountain, 29 per cent; Sebago, 2 per cent; and Kennebec, none. Thus, Kennebec is

TABLE I.—*Yield and percentage of U. S. No. 1 tubers obtained from tests of the potato variety Kennebec in comparison with standard varieties at Presque Isle, Maine*

Varieties	Yield of U. S. No. 1 Tubers per Acre						Percentage of U. S. No. 1 Tubers per Acre					
	1943	1944	1945	1946	1947	Mean	1943	1944	1945	1946	1947	Mean
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
Kennebec	615	375	433	442	523	478	97	99	96	99	97	97.6
Green Mountain	556	374	410	473	480	459	99	97	94	97	96	96.6
Katahdin	479	244	347	341	495	381	98	95	95	95	99	96.4
Chippewa	564	333	407	370	511	437	99	97	95	95	97	96.6
Sebago	498	301	373	353	470	399	98	93	94	95	96	95.2
Difference for significance at 5-per cent level	63	33	60	54	88	28						

TABLE 2.—*Specific gravity tests of the potato variety Kennebec in comparison with standard varieties grown at Presque Isle, Maine*

Variety	Specific Gravity					
	1943	1944	1945	1946	1947	Mean
Kennebec	1.092	1.080	1.088	1.093	1.082	1.087
Green Mountain	1.100	1.086	1.095	1.099	1.091	1.094
Katahdin	1.087	1.077	1.081	1.093	1.081	1.084
Chippewa	1.079	1.073	1.076	1.080	1.073	1.076
Sebago	1.088	1.072	1.082	1.093	1.079	1.083
Difference required at 5-per cent level	.008	.006	.004	.003	.002	.003

superior to Sebago for blight resistance in the vines and is at least its equal for resistance in the tubers.

In the mild mosaic exposure tests the Kennebec has been highly resistant to the mild mosaic virus. As yet this disease has not been transmitted to the Kennebec after exposure for several seasons to 100-per cent-infected Green Mountains.

Plants of Kennebec showing leaf roll have been found in small numbers in the field, but the corresponding symptoms of net necrosis in the tubers due to current-season infection have never appeared in the tests. For 3 years Kennebec was exposed in 5-hill plots to leaf roll in the net necrosis exposure tests. Eventually its plants were infected with leaf roll, but net necrosis in the tubers was not evident. In 1947 four varieties, including Kennebec, were planted in 20-hill rows, replicated three times, adjacent to rows of Irish Cobbler infected 100-per cent with leaf roll. At harvest time these samples were stored under optimum conditions for the development of net necrosis symptoms in the tubers. In December they were examined and recorded as indicated in table 5.

TABLE NO. 5.—*Variety comparison for net necrosis resistance at Presque Isle, Maine, in 1947*

Variety	Total Tubers[1]	Total Netted[1]	Percentage Netted
	No.	No.	Per cent
Mohawk	177	131	74.0
Green Mountain	222	86	38.7
Sebago	218	22	10.1
Kennebec	194	0	.0

[1]Total number for three replications.

TABLE 3.—*Comparative yield and specific gravity of Green Mountain, Katahdin, Mohawk, Sebago, and Kennebec at five locations in Maine in 1946*[1]

Variety	Locations in Maine											
	Fort Kent[1]		Presque Isle		Patten		Hampden		Dover-Foxcroft		Mean	
	Specific Gravity	U. S. No. 1 Tubers per Acre	Specific Gravity	U. S. No. 1 Tubers per Acre	Specific Gravity	U. S. No. 1 Tubers per Acre	Specific Gravity	U. S. No. 1 Tubers per Acre	Specific Gravity	U. S. No. 1 Tubers per Acre	Specific Gravity	U. S. No. 1 Tubers per Acre
		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.
Green Mountain	1.076	869	1.099	473	1.086	614	1.080	342	1.083	420	1.085	544
Katahdin	1.071	665	1.093	341	1.082	464	1.074	289	1.077	305	1.079	413
Mohawk	1.079	728	1.103	423	1.085	483	1.079	299	1.085	307	1.086	448
Sebago	1.076	728	1.093	353	1.080	565	1.071	267	1.082	410	1.080	465
Kennebec	1.072	810	1.093	480	1.086	559	1.074	445	1.084	550	1.082	569

[1]Four replications of 25 hills for each variety at each location were averaged.

TABLE 4.—*Comparative yield and specific gravity of Green Mountain, Katahdin, Mohawk, Sebago, and Kennebec in four locations in Maine in 1947*[1]

Variety	Locations in Maine									
	Van Buren		Presque Isle		Patten		Old Town		Mean	
	Specific Gravity	Yield per Acre	Specific Gravity	Yield per Acre	Specific Gravity	Yield per Acre	Specific Gravity	Yield per Acre	Specific Gravity	Yield per Acre
		Bu.		Bu.		Bu.		Bu.		Bu.
Green Mountain	1.077	657	1.091	565	1.078	603	1.089	585	1.084	602
Katahdin	1.073	537	1.070	510	1.069	582	1.079	451	1.073	520
Mohawk	1.078	540	1.086	491	1.079	599	1.089	539	1.083	542
Sebago	1.070	502	1.079	471	1.071	533	1.080	503	1.075	502
Kennebec	1.073	664	1.082	593	1.074	821	1.083	619	1.078	674

[1]Averages for 10 replications of 25 hills each, except at Old Town, Maine, where there were 8 replications.

The Kennebec appears to be more resistant to net necrosis than Sebago. The keeping quality of the tubers is excellent in the farm storage house at Presque Isle, Maine. From general observation, it appears in this respect to be superior to Sebago and as good as Green Mountain or Mohawk.

It should also be pointed out that the tubers of Kennebec are much more easily detached from the vines than are those of Sebago. This characteristic should be appreciated by growers who have had to pay a premium to get their Sebago potatoes picked.

Adaptation and Comparison

Kennebec has been tested for adaptation through the National Potato-Breeding Program. It was included in a group of more than 400 selections, single tubers of which were sent to 20 cooperating state experiment stations for the 1943 crop. A number of the cooperators selected it for further trial. Since that time it has been sent out in larger lots, and the results show that it is widely adapted. The reports vary somewhat, but in general the yields of the new variety are as good as or better than those of the standard varieties for most of the localities in which tests have been made. Its blight resistance is quite outstanding in all locations where this disease is a factor, with the exception of Hawaii where it became rather severely infected with late blight in 1947. This may indicate that different physiologic races of the blight organism are prevalent in Hawaii or that conditions there are especially favorable for the development of the disease.

As has already been shown (tables 3 and 4), Kennebec is very promising as a commercial variety in several sections of Maine besides Aroostook County. Relatively high yields and dry-matter content were obtained in the tests from Bangor northward. In 1946 it ranked first in yield in five tests in different parts of Maine in comparison with Green Mountain, Katahdin, Mohawk, and Sebago, and was first again in 1947 in four tests in comparison with the same four varieties.

It has been rather outstanding in a number of tests in New York State in 1945, 1946, and 1947; so much so that Dr. E. V. Hardenburg of the Division of Horticulture, Cornell University, Ithaca, New York, wrote in his 1947 report: "Seedling B 70-5 gave the highest average yield of any tested in 1947. This is in line with its performance in 1946. It appears to have everything to commend it, including yield, marketability, blight resistance, internal quality, and fairly early maturity."

At State College, Pennsylvania, Kennebec was the highest yielder in a test of 22 varieties. It yielded 472 bushels per acre as compared

with 263 for Rural, 318 for Russet Rural, and 271 for Green Mountain. In the 1947 Rhode Island tests Kennebec showed a relatively large amount of leaf roll but produced 500 bushels per acre as compared with 486 for Green Mountain.

In 1947 at Belle Glade, Florida, Kennebec gave a total of 272 bushels per acre as compared with 212 bushels for Triumph and 219 for Katahdin. It was outyielded by Pontiac with 288 bushels per acre. The report showed a slight amount of late blight and southern bacterial wilt in the Kennebec. In respect to bacterial wilt it showed less infection than Sebago, which was intermediate.. Kennebec was given a rating of 1 and Sebago 3, where 0 showed no infection and 5 indicated serious damage with wilt.

At Fort Pierce, Florida, no late blight infection was reported on Kennebec; but there was a moderate amount of early blight infection about 6 weeks after emergence, and this became very severe 15 days later when the plants were 98 per cent defoliated. At the South Carolina Truck Experiment Station, Charleston, South Carolina, Kennebec yielded 453 bushels per acre in comparison with 398 for Irish Cobbler—a significant difference. At Wadmalaw Island, South Carolina, Kennebec yielded 375 bushels per acre as compared with 387 bushels for Irish Cobbler—not a significant difference.

At Shafter, California, Kennebec has outyielded the standard variety White Rose and usually produces a higher percentage of U. S. No. 1 tubers.

From these and other records it is evident that Kennebec is widely adapted.

Dissemination

Several of the State organizations increased Kennebec in 1948, but most of this increase will be sold to foundation seed growers and increased again before it is put on the open market. This is the only way that an adequate supply of seed stock can be produced, since, if the limited amount of seed that is available at present is sold to growers of table stock it would be several years before a worth-while seed supply would be available. Therefore there will be no seed for general distribution until the fall of 1949.

The Department of Agricuture has no seed either for free distribution or for sale. Small lots will be sent out to cooperating State experiment stations for further tests, but none will be available for individual growers.

Summary

The Kennebec is a new variety of potato that combines high yield and good cooking quality with a high degree of resistance to late blight in both vines and tubers. In field-exposure tests it has not yet shown the symptoms of mild mosaic or net necrosis. It is late in maturing as grown in Maine, but has been considered medium-late in tests in other States. It is widely adapted. It produces smooth, well-shaped tubers with shallow eyes. Like all other varieties of potatoes, it varies in quality according to the environment in which it is grown and the cultural practices of the growers. As produced in the test plots on Aroostook Farm, Presque Isle, Maine, it has shown excellent market and cooking quality. The keeping qualities in storage appear to be excellent. Kennebec should replace Katahdin in some sections because of its higher yielding ability, its superior cooking quality, and its high degree of resistance to late blight. It should replace Sebago to a large extent because of a higher degree of resistance to late blight and because the tubers of Kennebec are more easily detached from the vines at harvest time than are those of Sebago.

SUSCEPT RANGE OF THE POTATO RING ROT BACTERIUM

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Introduction

The following study was undertaken to discover a test plant which, upon inoculation with questionably infected material, would produce rapid, confirming symptoms to indicate presence of the ring rot bacterium. By the end of the limited trials, no better species was found than tomato, a suscept that had previously been suggested for the purpose. Nevertheless, the resultant data are presented at this time for whatever bearing they may have on an allied consideration—the breeding of potatoes for resistance to ring rot. The data may also elucidate the role that additional suscepts play in the spread of this disease.

Historical

The only suscept that is affected by the ring rot organism under ordinary agricultural conditions is the Irish potato. Under conditions, however, of artificial inoculation, the bacterium is capable of causing infec-

tion in a number of other plants. Those which to date have been reported as being susceptible are: *Lycopersicum esculentum* Mill. (Spieckermann and Kotthoff 1914, Stapp 1930, Savile and Racicot 1937, Larson and Walker 1941, *et al.*), *Lycopersicum racemigerum* Lange (Spieckermann and Kotthoff 1914), *Solanum citrullifolium* A. Br. (Spieckermann and Kotthoff 1914), *Solanum commersonii* Dun. (Spieckermann and Kotthoff 1914), *Solanum melongena* L. (Larson 1942, 1944) and *Solanum integrifolium* Poir. (Larson 1943). In addition Stapp (1930) also described the isolation of the ring rot pathogen from artificially inoculated plants of *Pisum arvense* L. and *Phaseolus vulgaris* L., but for these he described the organism as being but "slightly pathogenic." In the case of beans no symptoms were evident, and it is questionable whether the wilting of field peas was actually due to the ring rot organism.

Species which have been inoculated with *Corynebacterium sepedonicum*, but which have been reported as giving no symptoms are recapitulated as follows:

Anisodus luridus Link & Otto—(Spieckermann and Kotthoff, 1914)
Atropa belladonna L.—(Sp. & Kotth., 1914; Larson, 1944)
Brassica napus L.—(Sp. & Kotth., 1914)
Browallia americana L.—(Larson, 1944)
Capsicum annuum L.—(Sp. & Kotth., 1914; Larson, 1944)
Datura metel L.—(Sp. & Kotth., 1914; Larson, 1944)
Datura meteloides DC.—(Larson, 1944)
Datura quercifolia Godr.—(Sp. & Kotth., 1914)
Datura stramonium L.—(Sp. & Kotth., 1914); Larson, 1944)
Datura tatula L.—(Sp. & Kotth., 1914)
Hyoscyamus albus L.—(Sp. & Kotth., 1914)
Hyoscyamus niger L.—(Sp. & Kotth., 1914)
Lupinus luteus L.—(Sp. & Kotth., 1914)
Lycium halimifolium Mill.—(Larson, 1944)
Lycopersicum Humboldtii Dun.—(Sp. & Kotth., 1914)
Nicandra physaloides Gaertn.—(Larson, 1944)
Nicotiana acuminata Hook—(Larson, 1944)
Nicotiana angustifolia Ruiz and Pav.—(Larson, 1944)
Nicotiana bigelovii S. Wats.—(Larson, 1944)
*Nicotiana cerinthoides**—(Sp. & Kotth., 1914)
Nicotiana chinensis Fisch.—(Larson, 1944)
Nicotiana glutinosa L.—(Larson, 1944)

*Not designated by the author whether this is *N. cerinthoides* Hornem, or *N. cerinthoides* Vitm.

Nicotiana longiflora Cav.—(Larson, 1944)
Nicotiana multivalvis Lindl.—(Larson, 1944)
Nicotiana noctiflora Hook—(Sp. & Kotth., 1914)
Nicotiana quadrivalvis Pursh.—(Larson, 1944)
Nicotiana repanda Willd.—(Larson, 1944)
Nicotiana rustica L. (Sp. & Kotth., 1914; Larson, 1944)
Nicotina rustica L. var. *brasilia* Schrank.—(Larson, 1944)
Nicotiana rustica L. var. *humilis*—(Larson, 1944)
Nicotiana sanderae Hort.—(Sp. & Kotth., 1914; Larson, 1944)
Nicotiana sylvestris Speg. & Comes.—(Larson, 1944)
Nicotiana tabacum L.—(Larson, 1944)
Nierembergia hippomanica Miers.—(Larson, 1944)
Pelargonium zonale L'Herit.—(Stapp, 1930)
Petunia violacea Lindl.—(Larson, 1944)
Physalis Alkekengi L.—(Sp. & Kotth., 1914)
Physalis aequata Jacq. f.—(Larson, 1944)
Physalis heterophylla Nees—(Larson, 1944)
Physalis heterophylla var. *ambigua* (Gray) Rydb.—(Larson, 1944)
Physalis lanceolata Michx.—(Larson, 1944)
Physalis longifolia Nutt.—(Larson, 1944)
Physalis virginiana Mill.—(Larson, 1944)
Salpiglossis sinuata Ruiz & Pav.—(Larson, 1944)
Schizanthus pinnatus Ruiz & Pav.—(Sp. & Kotth., 1914)
Schizanthus wisetonensis Hort.—(Larson, 1944)
Soja hispida Moench.—(Stapp, 1930)
*Solanum balbisii**—(Sp. & Kotth., 1914)
Solanum carolinense L.—(Larson, 1944)
Solanum ciliatum macrocarprum—(Sp. & Kotth., 1914)
Solanum dulcamara L.—(Sp. & Kotth., 1914; Larson, 1944)
Solanum guyanense—(Sp. & Kotth., 1914)
Solanum nigrum L. (Sp. & Kotth., 1914; Larson, 1944)
Solanum pseudocapsicum L.—(Larson, 1944)
Solanum rostratum Dun.—(Larson, 1944)
Solanum spinosissimum Lodd.—(Sp. & Kotth., 1914)
Solanum triflorum Nutt.—(Larson, 1944)
Vicia faba L.—(Stapp, 1930)

*Not indicated by the author whether this is *S. balbisii* Boj. or *S. balbisii* Dun.

PROCEDURE

For this study solanaceous seeds and tubers were solicited from potato breeders and specialists in the Solanaceae, both at home and abroad. **All testing was done on potted plants grown in the greenhouse. In the preliminary runs at least six plants of each species were inoculated and an additional four plants accompanied these as uninoculated checks. In the case of species proving to be susceptible, the number of plants used to test each species ranged from 1 to 36, the number being governed in the lower range by the limitation of available seed.

Plants were inoculated by means of sterilized needles coated with inoculum derived either from pure cultures or from infective ooze of diseased potato tubers, as indicated in table 1. The stab to the vascular region of the main stem was made several centimeters above the ground line, and precautions were taken to prevent over-rapid desiccation of the infection court. Seedlings were inoculated when the diameters of their stems at the point of inoculation were approximately 3 millimeters.

Temperatures over the extended period of testing varied somewhat, an attempt having been made, however, to keep the greenhouse at 24° C. Inoculated tomato plants, grown together with the various test series, indicated by their constant susceptibility that, although temperature variaions may have occurred, they were nevertheless within the range permitting infection.

DATA

Data are summarized in table 1. Newly reported suscepts include 25 species. Reports of 5 previous suscepts are confirmed. Symptoms are recorded in terms of number and percentage of plants reacting and the range and average of days elapsing to first expression of macroscopic symptoms—usually a chloronemia and wilting of the leaves.

**The following sources are represented, and appreciation is herewith expressed for the generous cooperation received:

- H. A. Senn, Central Experimental Farm, Department of Agriculture, Ottawa, Canada.
- J. G. Hawkes, School of Agriculture, University of Cambridge, Cambridge, England.
- J. P. Sleesman, Ohio Agricultural Experiment Station, Wooster, Ohio.
- F. A. Krantz, Department of Horticulture, University of Minnesota, St. Paul, Minnesota.
- H. N. Racicot, Central Experimental Farm, Department of Agriculture, Ottawa, Canada.
- D. Reddick, Department of Plant Pathology, New York State College of Agriculture, Ithaca, New York.
- W. C. Muenscher, Department of Botany, New York State College of Agriculture, Ithaca, New York.

TABLE 1.—*Suscepts of the ring-rot organism, Corynebacterium sepedonicum (Spieck. u. Kotth.) Skapt & Burkh.*

Suscept	Inoculation with Ooze: Inoculated Plants		Inoculation with Ooze: Days to First Symptom		Inoculation with Pure Cultures: Inoculated Plants		Inoculation with Pure Cultures: Days to First Symptom	
	Number	Per cent Showing Symptoms	Range	Average	Number	Per cent Showing Symptoms	Range	Average
Newly Reported Suscepts:								
1. *Athenaea* sp. (BPI 126966)	6	67	40-65	53				
2. *Solanum antipoviczii*	19	68	17-40	33	7	57	28-33	31
3. *Solanum ballsii*	1	100	16	16	1	100	23	23
4. *Solanum chacoense*	10	100	19-65	29	4	75	21-28	23
5. *Solanum corymbosum*	8	100	12-19	14	4	75	12-17	15
6. *Solanum demissum atypicum*	8	50	19-43	31	3	0	—	—
7. *Solanum endlicheri*	6	100	19-30	26				
8. *Solanum fendleri*	9	100	17-42	24	3	100	17-27	20
9. *Solanum jujuyense*	3	67	28-43	36	2	0	—	—
10. *Solanum mammosum*	8	75	17-60	33	3	100	12-60	33
11. *Solanum parodii*	13	92	17-51	24	6	83	17-60	24
12. *Solanum pampasense*					1	100	28	28

TABLE 1. (*Continued*)—*Suscepts of the ring-rot organism, Corynebacterium sepedonicum (Spieck. u. Kotth.) Skapt. & Burkh.*

Suscept	Inoculation with Ooze: Inoculated Plants		Inoculation with Ooze: Days to First Symptom		Inoculation with Pure Cultures: Inoculated Plants		Inoculation with Pure Cultures: Days to First Symptom	
	Number	Per cent Showing Symptoms	Range	Average	Number	Per cent Showing Symptoms	Range	Average
13. *Solanum radicans*	12	58	12-19	13				
14. *Solanum tequilense*	7	43	17-19	18	2	100	27	27
15. *Solanum tlaxcalense*	1	100	27	27				
16. *Solanum vavilovii*	9	100	28-40	32	3	67	28-33	31
17. *Solanum verrucosum*	10	100	19-35	25	4	100	30-45	35
18. *Solanum warszewiczio*	6	83	40-65	12				
19. *Solanum* sp. (BPI 126461)	6	67	12	14				
20. *Solanum* sp. (BPI 127845)	6	50	12-19	37				
21. *Solanum* sp. (BPI 127848)	1	100	12	12				
22. *Solanum* sp. (BPI 129355)	1	100	12	12				
23. *Solanum* sp. (BPI 129381)	7	86	12-30	27				
24. *Solanum* sp. (Reddick No. M307)	11	82	13-87	62	5	100	16-87	49
25. *Solanum* sp. (Reddick No. M478)	3	100	12-17	14	5	100	12-50	27

TABLE I (*Concluded*)—*Suscepts of the ring-rot organism, Corynebacterium sepedonicum (Spieck. u. Kotth.) Skapt. & Burkh.*

Previously Reported Suscepts:								
1. *Lycopersicum esculentum*	6	100	15	15	23	100	13-28	17
2. *Solanum citrullifolium*	9	100	12-19	14	5	100	12-42	23
3. *Solanum commersonii*	28	100	17-50	25	16	94	17-50	26
4. *Solanum melongena*	6	50	19-40	26				
5. *Solanum tuberosum*	3	100	42-47	44	4	100	42-47	43

That symptoms observed were due to the inoculations was checked by comparing affected plants with others of the same species which were not inoculated or were punctured with sterile needles. A further relationship of wilt to infection was established on the basis of stem smears of affected plants. Such smears were made on glass slides from the cut surfaces of stems sectioned radially at a point approximately two centimeters from the site of inoculation. The smears were subsequently stained by the Gram technique and were examined for the presence of bacteria resembling, in their staining reaction, size, morphology, and grouping, the ring rot bacterium.

Those species of solanaceous plants which showed no susceptibility to the ring-rot organism during the course of this study are as follows:

Atropa belladonna L.
Capsicum annuum L.
Nicotiana tabacum L.
Physalis angulata Heyne
Saracha procumbens Math. ex Dun. & A. DC.
Solanum acaule Bitter
Solanum acaule var. *subexinterruptum**
Solanum aculeatissimum Jacq.
Solanum antigenum f. *hederisegmentatum**
Solanum demissum Lindl.
*Solanum demissum atrocyaneum**
Solanum demissum f. *tlaxpehualcoense**
Solanum dulcamara L.
Solanum gilo Requien
*Solanum guineense***
Solanum indicum Roxb.
Solanum neoantipoviczii var. *Reddickii* Bukasov
Solanum nigrum var. *pumila**
Solanum pyracanthum Jacq.
Solanum tripartitum Dun.
Solanum sp. (Reddick Acq. No. 1072)
Solanum sp. (BPI 123831)
Solanum sp. (BPI 126458)
Solanum sp. (BPI 126465)
Solanum sp. (BPI 126965)
Solanum sp. (BPI 127841)
Solanum sp. (BPI 127843)

*Authority not determinable.
**Not indicated whether this is *S. guineense* Lam. or *S. guineense* L.

Solanum sp. (BPI 127844)
Solanum sp. (BPI 127849)
Solanum sp. (BPI 129352)

In addition to the non-susceptible solanaceous species listed above, various crop plants were inoculated as previously described. The ooze from a number of potato tubers in an early stage of ring-rot infection was used as inoculum, and 12 plants of each variety were inoculated. None of the following showed above-ground macroscopic symptoms of infection even for 60 days following inoculation:

Apium graveolens L. (Celery, var. Salt Lake)
Beta vulgaris L. (Beet, var. Detroit Dark Red)
Brassica oleracea L. var. *acephala* DC. (Kale, var. Dwarf Green Curled
Brassica oleracea L var. *botrytis* L. (Cauliflower, var. Burpeeana)
Brassica oleracea L. var. *capitata* L. (Cabbage, var. Early Jersey Wakefield)
Brassica rapa L. (Turnip, var. Purple Top White Globe)
Cuscuta sp. (Tourn.) L. (Dodder)
Daucus carota L. (Carrot, var. Chanteney)
Helianthus sp. L. (Sunflower)
Lactuca sativa L. (Lettuce, var. Big Boston)
Phaseolus vulgaris L. (Bean, var. Pencil Pod Black Wax)
Pisum sativum L. (Pea, var. Little Gem)
Soja Max Piper (Soybean)
Spinacia oleracea Mill. (Spinach, var. Giant Thick-leaved)
Trifolium pratense L. (Red Clover)

Discussion

It should be pointed out that *Solanum demissum* occurs in the list of ring-rot suscepts as well as in the list of non-suscepts, differing only in that the former listing designates the *demissum* as *Solanum demissum atypicum*. Eleven plants of *S. demissum atypicum* were inoculated at various times over a period of two and a half years and of these, four showed external symptoms of ring-rot infection. Gram-stained smears of the affected stems were also prepared, and these showed the presence of *Corynebacterium sepedonicum*. On the other hand, 5 other collections of *S. demissum*, designated *S. demissum* f. *tlaxpehualcoense; S. demissum*, El desierto; *S. demissum*, Rio Janeiro; *S. demissum atrocyaneum*, El desierto; and *S. demissum Xitlense*, El desierto were tested, and of the 28 inoculated plants comprising this group, none showed any evidence of susceptibility. In conversation with Dr. Donald Reddick, who

annexed the appelative *"atypicum"* to the species *S. demissum,* the writer was informed that this variant differed from the typical *S. demissum* in that its foliage was of a little deeper green, that its leaflets in proportion were a little broader, also that the terminal leaflet formed a better ellipse, but that the hump was somewhat distal of center, and that the berry was a little paler than normal. A difference was also noted in the immunity of these two strains: the typical *demissum,* in the course of extensive testing by Dr. Reddick for late blight susceptibility, has repeatedly reacted as immune; the strain *atypicum,* on the other hand, has consistently shown a susceptibility to blight. This discrepancy between the two strains as to late blight as well as to ring-rot susceptibility, may have its explanation in a heterozygosity of resistance factors in the *atypicum* variant—a possibility suggested by its differing phenotypic, vegetative, and fruiting characteristics. To determine whether *Solanum demissum atypicum* differs from other *S. demissum* forms in its susceptibility to ring rot, or whether the species as a whole is but highly resistant, will require further investigation.

Especial attention has been called to *Solanum demissum* and its forms since that species has shown immunity to the important potato late blight disease, and has, therefore, been used by Reddick (1943) in breeding commercial potatoes resistant to the disease. Resistance or immunity of *S. demissum* to ring rot might conceivably be an additional factor in favor of its use as parentage material in a potato breeding program.

Summary

Twenty-five new suscepts of the potato ring rot organism, *Corynebacterium sepedonicum* (Spieckermann and Kotthoff) Skapt. and Burkh., are given. An additional 45 species are listed as showing no reaction to the disease. The differences in susceptibility between *Solanum demissum* and *S. demissum atypicum* are emphasized.

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THE EFFECT OF CHEMICAL VINE KILLERS ON YIELD AND QUALITY OF RED McCLURE AND BLISS TRIUMPH POTATOES

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Potato vine killers have come into vogue in Colorado during the last two years for the purpose of lengthening the harvest period and toughening the tuber skins to reduce scuffing and mechanical abrasion. Little was known about the effect of these chemicals on the tubers and since contradictory reports were being voiced it seemed that some factual evidence was needed. This was especially true for the San Luis Valley where bright red tubers bring a price differential on the market and where the maintaining of high cooking quality is a major consideration.

In 1946 and 1947 experiments were conducted at the Colorado Potato Station, Greeley, and at the San Luis Valley Branch Station[2]—to determine which vine killers were effective on potatoes grown under irrigation in the semi-arid west and what the effects were on the tubers.

Randomized block designs were used both years. In 1946 four replications were used at both places and in 1947 five replications were used at the Colorado Potato Station and six at the San Luis Valley Branch Station. All sprays were applied with a wheelbarrow sprayer at the rate of 100 gallons per acre about two weeks prior to a killing

[1]Horticulturist, U. S. D. A. Bureau of Plant Industry, Soils, and Agricultural Engineering.

[2]The writers wish to thank W. F. McGee, Supt. of the San Luis Valley Branch Station for his assistance in these investigations.

frost. One exception was at the San Luis Valley Branch Station in 1946 when a power sprayer was used to apply the chemicals.

Color measurements were made with the disc colorimeter as described by Sparks[2] and specific gravity was computed from the relationship: weight of the dry tubers in air divided by the difference between the weight of the tubers in air and the weight of the tubers when immersed in water. The data for stem end discoloration was not taken until about 75 days after harvest during which time the tubers were stored at approximately 40° to 50° F. in 1946. In 1947 the Triumph tubers were stored at about 40° to 60° F. and the Red McClure potatoes at room temperature. It was hoped that by waiting 75 days any discoloration that was to develop would appear. Determinations were made on samples of approximately 50 tubers from each plot.

Results

Table 1 gives the chemicals and the concentrations used at the Colorado Potato Station in 1946 and 1947, the relative speed of kill and the percentage of stem end discoloration. The effect of the chemicals on yield, grade, color and specific gravity was determined; but since none of the differences except in the case of specific gravity and stem

TABLE 1.—*Potato vine killer and the concentrations used, arranged according to the rate of kill on Triumph potatoes at the Colorado Potato Station, Greeley, Colorado, in* 1946-1947

Vine Killer	Concentration Used	Rate of Kill[1]	Percentage Stem End 1946	Discoloration 1947
Sodium Nitrite	100 lbs./100 gal. water	1	13.2	——
Dowspray 66	1 gal./100 gal. water + 2 lbs. aluminum sulfate	1	——	12.8
Dowspray 66	1 gal./100 gal. water + 10 lbs. copper sulfate	1	——	12.1
Dowspray 66	1 gal./100 gal. water	2	14.1	10.6
Sinox	2 gal./100 gal. water + 10 lbs. ammonium sulfate	2	13.5	——
Ammonium sulfate	200 lbs./100 gal. water	4	——	8.1
Hammond's weed killer	2½ gal./100 gal. water	6	——	7.7
Sodium nitrite	50 lbs./100 gal. water	6	10.4	9.9
Check			19.2	13.1

[1]The smaller the number the quicker the kill, but a rating of 1 is not to be construed to mean the kill was twice as fast as a rating of 2, nor 6 times as fast as a rating of 6.

end browning approached significance they are not included in the table. In 1946 there was almost significantly more stem end discoloration in the tubers from the untreated check than in those from vines which had been killed with a vine killer as shown in table 1. In 1947 the vine killers were applied only two days before a frost which killed 50 per cent of the foliage and consequently no significant differences were found.

The effect of potato vine killers on Red McClure potatoes in 1946 is shown in table 2. The vine killers were applied seventeen days before

TABLE 2.—*The effect of Dowspray 66 and Sinox on the color, specific gravity, and percentage of stem discoloration of Red McClure potatoes when applied* 17 *days ahead of the first killing frost in* 1946.

Vine Killer	Concentration Used	Per cent Stem End Discoloration	Per cent Eugenia Red Color	Specific Gravity
Sinox	1 gal/100 gal. water + 10 lbs. ammonium sulfate	19.4	72.1[1]	1.0796
Dowspray 66	1 gal./100 gal. water	18.9	71.9	1.0822
Check		8.9*	76.2*	1.0874*
M S.D. 1 Per cent		13.2	4.89	.0064
M.S.D. 5 Per cent		8.7	3.23	.0042

[1]The color rating indicates the percentage of the Eugenia red component, the remainder being light pinkish cinnamon (Ridgeway's Color Standard).

frost killed the vines on the check plots and the tubers were dug two days later.

From the data in table 2 it can be seen that there was no difference between the effect of Sinox and Dowspray 66 insofar as stem end discoloration, color of tuber or specific gravity are concerned. However, tubers from the vine-killed plots showed markedly more stem end discoloration, significantly less color, and a much lower specific gravity than the tubers from the check plots which had been permitted to grow about sixteen days longer.

In the 1947 experiment at the San Luis Valley Branch Station two sets of check plots were included. One was harvested the day following the application of the vine killers to determine the status of the tubers at the beginning of the experiment. The other served as the untreated check. Fourteen days after the vine killers were applied, and while the

vines on the untreated check were still green, a killing frost, which killed the vines to the ground, occurred. Two days later, on the 16th of September, the plots were dug. The results are shown in table 3.

Table 3 indicates that the vine killers were not equally effective in producing a rapid kill. Of the materials used Sinox and Dowspray 66 alone and in combination with other materials gave the quickest kill. No significant "F" value was found by analysis of variance for stem end discoloration when comparing the treatments listed in table 3. Tuber color was at its best at the time the vine killers were applied. Specific gravity of the tubers was the highest where the vines lived the longest. There was also some indication, at odds of nearly 19:1 that the specific gravity was not so good in those tubers where the vines have been killed by a vine killer and the tubers left in the soil for sixteen days, as in those tubers harvested at the beginning of the experiment.

There was so much variation within treatments that it was not possible to determine the amount of increase in yield obtained by letting the plants live two weeks longer. Nevertheless the tubers were graded into three sizes: below 1½ inches in diameter, 1½ inches to 2 inches, and over 2 inches.

It was found, in table 3, that digging the tubers two weeks ahead of the frost increased the amount of tubers under two inches in diameter by 5.7 per cent by weight, at odds greater than 99:1. Killing the vines with a vine killer did not cause significantly more tubers under two inches in diameter than occurred in the untreated check which was harvested on the 16th of September. The difference in total yield was not significant, because of the large variation within treatments.

Discussion

In some preliminary work with potato vine killers in the greenhouse it was found that Dowspray 66 when combined with copper sulfate at the rate of ten pounds per 100 gallons of spray would kill late blight spores[1] whereas Dowspray 66 alone or in combination with aluminum sulfate did not. Copper sulfate is more expensive than aluminum sulfate but the added cost may be more than off-set by the fungicidal effects in late blight areas should it prove effective against late blight in the field.

Stem end discoloration has been a major concern and no doubt has limited the use of vine killers to some extent. However, at this

[1]Determinations made by Dr. W. D. Thomas of the Botany Department of Colorado A. & M. College.

TABLE 3.—*The effect of various potato vine killers on the per cent grade, color, stem-end discoloration, and specific gravity when applied to Red McClure potatoes two weeks ahead of the first killing frost*

Vine Killer	Concentration Used	Rate of Kill	Pct. Stem-end Discoloration	Pct. Eugenia Red Color*	Specific Gravity	Tubers 2" in Diameter
Dowspray 66	2 gal./100 gal. water + 2 lbs. aluminum sulfate	1	11.4	65.5	1.0834	94.1
Dowspray 66	2 gal./100 gal. water + 10 lbs. copper sulfate	1	7.7	64.2	1.0831	94.7
Dowspray 66	1 gal./100 gal. water + 2 lbs. aluminum sulfate	2	11.0	65.5	1.0843	94.0
Dowspray 66	1 gal./100 gal. water + 10 lbs. copper sulfate	2	9.8	64.3	1.0827	94.0
Sinox	2 gal./100 gal. water + 10 lbs. ammonium sulfate	2	10.3	63.4	1.0821	93.7
Ammonium sulfate	200 lbs./100 gal. water	5	10.2	63.5	1.0839	94.2
Sodium nitrite	50 lbs./100 gal. water	6	13.1	65.3	1.0858	93.7
Hammond's weed killer	2½ gal./100 gal. water	8	8.9	64.4	1.0851	93.9
Fairmont weed killer	2½ gal./100 gal. water	8	8.2	64.8	1.0833	94.6
Check	Dug September 2, 1947	—	—	68.1	1.0859	88.8
Check	Dug September 16, 1947	—	9.5	64.9	1.0873	94.5
M.S.D. 5 Pct.			N. S.	2.26	0.0027	1.19
M.S.D. 1 Pct.				3.02	0.0036	1.59

*The color rating percentage of the Eugenia red component, the remainder being light pinkish cinnamon (Ridgeway's Color Standards).

time it seems doubtful that any additional discoloration was caused by their use. Photographs made of the various types of stem-end discoloration in 1946 show it is quite possible that some of the discoloration was due to net necrosis and probably not to the vine killers used. In 1947 it was found that stem-end discoloration could be distinguished from net necrosis by the use of ultraviolet light, consequently in 1947 tubers listed under stem-end discoloration are those that were discolored but did not show fluorescence when cut about one-fourth of an inch from the stem end.

Of the vine killers tested under Colorado conditions it appears that only those worthy of consideration are Dowspray 66, alone or in combination with aluminum or copper sulfate, and Sinox. Sodium nitrite at high concentration proved to be an effective vine killer, but its use is not recommended because of the already high sodium content of the soils.

Summary

Chemical potato vine killers were tested at The Colorado Potato Station on Bliss Triumph potatoes and at the San Luis Valley Branch Station on Red McClure potatoes in 1946 and 1947. In 1946 at the Colorado Potato Station there was almost significantly more stem-end discoloration in tubers from the untreated check than in those from the treated plots. At the San Luis Valley Branch Station the same year there was significantly more stem-end discoloration in the tubers from the chemically treated plots than in those from the untreated check.

The 1947 results at the Colorado Potato Station were inconclusive due to a killing frost just two days after the chemical vine killers were applied. The results at the San Luis Valley Branch Station in 1947 indicate: (1) that when the tubers were harvested, about two weeks before harvesting the untreated check, a significant decrease in yield of tubers more than two inches in diameter resulted; (2) that killing the vines prematurely resulted in a lower specific gravity; and (3) that tuber color faded with maturity. Killing the vines with a vine killer about two weeks ahead of the first killing frost did not decrease the amount of tubers which were more than two inches in diameter. None of the vine killers used in 1947 caused a significant increase in the amount of stem-end discoloration.

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SOIL FERTILITY INVESTIGATIONS WITH POTATOES IN WISCONSIN[3]

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Although larger quantities of fertilizer had been used for potatoes in Northern Wisconsin than for most other crops in the state, in many cases yields have not been satisfactory. During the course of the investigation reported here, which was started in 1942, nutritional disorders of potatoes involving manganese toxicity, magnesium deficiency, potassium deficiency and nutrient unbalance have appeared in the field. These nutritional disorders, in many cases, were the limiting factors in the yields of potatoes. In the past, growers have used, within narrow limits, the same amounts of plant food irrespective of soil fertility status. A reluctance to use lime, because of the danger of scab infestation, has led to excess soil acidity and magnesium deficiency in some cases. The use of the same amounts of plant foods on all soils has led to nutrient unbalance.

In order to determine why lower yields were becoming more common in Northern Wisconsin, greenhouse, laboratory, and field experiments were started in 1942 and the results are reported here.

PROCEDURES

In all field experiments four replications of each treatment were made in a randomized block arrangement. Individual plots were four rows wide and 60′ long. Fertilizer applied in the row was applied in bands with commercial potato planters. Fertilizers applied broadcast were usually weighed out for each plot and applied by hand or they were applied with the fertilizer broadcaster which had been previously calibrated. The amount of fertilizer actually applied to each plot was determined by adding a known amount to the machine and weighing the fertilizer remaining in the hopper after application. Fertilizer was usually applied to the soil after plowing and was double disced so as to mix it directly with the top 3-5″ of soil.

Lime was applied in a manner similar to fertilizer. In all cases finely ground dolomitic limestone was used. This material contains approxi-

[1]Contribution from the Department of Soils, University of Wisconsin, Madison 6, Wis. Published with the permission of the director of the Wisconsin Agricultural Experiment Station.

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mately 41 per cent magnesium carbonate and 47 per cent calcium carbonate. It is ground so that about 97 per cent passes a 100-mesh screen and 72 per cent passes a 300-mesh screen.

For harvest, five feet was hand dug and discarded from the end of each plot and the center two rows 50 feet long taken for yield. The tubers were weighed in the field and yields calculated to an acre basis.

Available phosphorus and potassium determinations were made by the Truog quick test procedure. Available calcium and magnesium were determined by displacement with normal, neutral, ammonium acetate solutions and subsequent precipitation and titration. The pH of these soils was determined in part colorimetrically and in part with a glass electrode.

Chemical Composition of Soils

Preliminary investigations indicated that the potato soils, after 10 to 30 years of cultivation contained high amounts of available phosphorus, were low in available potassium, and were very strongly acid. During this investigation, numerous samples were collected from virgin soils and from soils where potatoes had been grown for a number of years. These samples were analyzed for available phosphorus, potassium, calcium, and magnesium, and the pH of these soils was determined. These data are given in table 1. Although virgin samples could not always be taken near cultivated fields, it is felt that the results given are representative of the nutrient status of the soils in northern Wisconsin.

As can be seen in table 1, 10 to 30 years of cropping to potatoes has resulted in an increase in acidity from medium acid in the virgin soils to very strong acidity in the cultivated soils. The available phosphorus content of the cultivated soils is from two to four times that of the virgin soils. The available potassium content of the cultivated soils has decreased so it is now about one-half to three-fourths that of the virgin soil, the available calcium content is about 60 per cent of that of the virgin soils, and the available magnesium content ranges from about one-third to one-half as much in the cultivated as in the virgin soils. This increase in available phosphorus and decrease in available potassium, calcium, and magnesium show that fertilizers on these soils have not been properly balanced.

Common applications of fertilizer in the past have been 800 pounds to the acre of such analyses as 4-8-8, 3-12-12, and in rare instances, 3-9-18 applied in bands at side of the seed in the row Hawkins *et al.* (3)

TABLE I.—*Chemical composition of virgin and cultivated northern Wisconsin potato soils.*

Soil Type	Number of Samples	pH	Pounds per Acre Available			
			P	K	Ca	Mg
			Virgin Soils			
Vilas sandy loam	5	5.3	68	168	887	116
Onamia loam	6	5.3	65	124	985	121
Omega sand	9	5.5	35	120	685	97
Antigo silt loam	7	5.4	44	135	960	127
			Cultivated Soils			
Vilas sandy loam	12	4.6	124	85	529	63
Onamia loam	27	4.4	127	85	578	57
Omega sand	15	4.6	131	71	375	35
Antigo silt loam	25	4.5	126	93	670	58

(4)[3] have shown that a good yield of potatoes will contain in the tops and tubers 40 pounds of nitrogen (N), 30 pounds of phosphoric acid (P_2O_5) and 250 pounds of potash (K_2O). It is obvious that because the potato crop uses a low amount of phosphorus and a high amount of potash, and because the fertilizers applied did not contain a somewhat similar ratio of phosphorus to potassium, the phosphorus content of the cultivated potato soils has increased although the potassium content had decreased.

The results show that for best growth and yields of potatoes these soils are now too low in available calcium, magnesium and potassium.

FERTILIZER EXPERIMENTS

The rotation used by most of the certified seed growers in northern Wisconsin consists of oats seeded to red clover, red clover, and potatoes. The oats is combined, all the straw is left on the field the first year. The second year red clover is combined for seed but no hay is removed and in the fall it is usually worked for weed control and in so doing the clover is thoroughly chopped up and incorporated into the soil. The land is plowed the following spring and potatoes planted. This is a very good rotation and one which supplies a considerable amount of nitrogen as well as other plant foods for the potato crop. Most of the fertilizer experiments reported here were with potatoes in such a rotation.

Because of rather low summer rainfall with relatively poor distribution during July and August in Wisconsin, the application of more

[3]Figures in parenthesis refer to "Literature Cited."

than 800 pounds per acre of the fertilizer in the row is usually not beneficial to potatoes. Therefore, it was decided early in this investigation that because larger amounts of fertilizer were obviously necessary for potatoes, it was best to apply them broadcast. Several experiments conducted with more than 800 pounds of fertilizer in the row have confirmed this observation. Various ratios of nitrogen, phosphoric acid and potash were applied broadcast and the results obtained with these various ratios are given in table 2. Numerous other ratios were tried and discarded after one or two ears' trial because of obvious poor results.

TABLE 2.—*Yields of potatoes as influenced by various mixtures of complete fertilizers applied broadcast in addition to the application of 800 pounds of 3-12-12 applied in the row. Average of experiments on five fields during three years.*

Fertilizer Application	Acre Yield Bushels
Check, no fertilizer	136
Fertilizer in row, none broadcast	180
" " " plus 1200 lbs. 6-6-18 broadcast	270
" " " " 1200 lbs. 6-3-18 "	257
" " " " 1200 lbs. 6-6-27 "	243
" " " " 1200 lbs. 6-6-9 "	239
" " " " 1200 lbs. 12-6-18 "	236

The data show, that although there was a large increase in yield with the application of 800 pounds of 3-12-12 in the row, additional applications of 1200 pounds of a high potash fertilizer gave much greater increases in yield. It was found that the best analysis fertilizer to apply broadcast was a 6-6-18 fertilizer. As shown in table 2, although the average yields were increased 44 bushels by the application of fertilizer in the row, the broadcast application of 1200 pounds of 6-6-18 in addition to the row fertilizer gave a further increase in yields of 90 bushels per acre. This fertilizer ratio gave better results than did higher or lower potash, nitrogen, or phosphate, on the average. The highest experimental yields, however, was obtained with a 6-3-30 fertilizer in 1942, a year of good rainfall. Field appearance of the potatoes with this treatment are shown in figure 1. The plot shown yielded 606 bushels per acre but in other years of less favorable distribution of rainfall, the yields with this treatment were much lower than with 6-6-8 fertilizer.

FIG. 1. Fertilizer experiment with Triumph potatoes on Omega sand, 1942.
Dark colored plot between two men received 700 pounds of 3-12-12 side seed plus 1200 pounds of 6-3-30 broadcast. Yield of plot 606 bushels per acre.
Right of men—700 pounds 3-12-12 side seed, yield 410 bushels per acre.

In table 3 yields are given, comparing results obtained in various years with no fertilizer, row only, and row plus 6-6-18 applied broadcast. As can be seen, the yields are quite variable, depending on weather and soil conditions. In every year, however, the broadcast application of fertilizer resulted in an increase of yield over the row fertilization. Because most of the potato soils now contain high phosphorus and low potassium, it is felt that this fertilizer treatment will probably give the best results on the majority of the soils. There are, however, a few soils that are relatively high in available potassium, and with these soils, the broadcast application of fertilizer will not always be profitable, especially where large crops of clover are grown and turned under to supply the nitrogen needed.

LIME EXPERIMENTS

As previously shown, the potato soils in northern Wisconsin are now too acid for best growth of potatoes due partially to excess manganese present in these soils but also to a lack of calcium and especially

TABLE 3.—*Yields of potatoes with no fertilizer, row application only, and row plus broadcast applications on different soil types. Results from nine fields over six-year period.*

Soil Type	Year	Acre Yield in Bushels		
		No Fertilizer	800 Lbs. 3-12-12 in Row	800 Lbs. 3-12-12 in Row Plus 1000 to 1200 Lbs. 6-6-18 Broadcast
Omega sandy loam	1945	90	148	220
Omega sandy loam	1943	119	127	174
Antigo silt loam	1946	188	299	319
Omega sand	1947	191	204	280
Antigo silt loam	1945	199	265	426
Omega sandy loam	1944	254	282	297
Antigo silt loam	1944	260	296	354
Omega sand	1942	268	409	563
Onamia sandy loam	1947	320	390	474
Average		209	269	345

magnesium. In 1946, magnesium deficiency symptoms were found for the first time in Wisconsin. These were found in northern Wisconsin on potatoes. The apparent inefficiency of potatoes in the absorption of phosphorus from the soil might probably be due to a lack of magnesium in the soil. It has been shown (5) that when the magnesium content of the soil was low, the phosphorus content of pea seed could be increased by increasing the supplies of available magnesium. It is quite possible that the same mechanism works with potatoes.

Before this work was started in Northern Wisconsin it had been noted that on some soils there appeared a severe stem streak necrosis of potatoes which caused early death of the plant and subsequent reduced yields. During this investigation it was found that the stem streak necrosis occurred more often on soils more acid than pH 5.1 and that it was caused by excess maganese in the soil solution. The high acidity brought about conditions which were favorable for the change of the rather insoluble manganese dioxide to the highly soluble manganous manganese. It was also shown that the excess amounts of manganese in the soil solution could be removed by the application of small amounts of finely ground limestone. This work has been reported in detail elsewhere (1) (2).

Because of these three factors, low calcium and magnesium and excess manganese, not only has the potato crop been affected adversely but in many cases it has not been possible to grow a green manure clover

crop. Lime has not been applied more generally because of a fear of scab. Results given in table 4 show that the application of lime directly

TABLE 4.—*Yields of potatoes as influenced by the application of lime at the rate of 300 to 1000 pounds per acre with various fertilizer treatments. Average of five fields during four years.*

Fertilizer Application	Acre Yield, Bushels		
	Unlimed	Limeed	Increaese Due to Liming
None	180	194	14
800 lbs. 3-12-12 in row	241	265	24
800 lbs. 3-12-12 in row plus 1200 lbs. high potash fertilizer broadcast	281	314	33

to potatoes increases the yield on the average from 14 to 30 bushels per acre. Because of this, the application of 300 to 1000 pounds of finely ground limestone is recommended on potato soils more acid than pH5.0. Furthermore preliminary experiments with various fertilizer materials have shown that in some cases yields have been appreciably increased by the addition of soluble magnesium, as sulfate of potash-magnesia, in the fertilizer applied. Because the magnesium content of these soils are so low and because only a small amount of dolomitic limestone can be added the application of soluble magnesium in the fertilizer is recommended.

SODIUM EXPERIMENTS

Because of the possibilities of potassium supplies being short during the war, a series of sodium experiments with potatoes were initiated in 1943. Results in figure 2 show that the dry weights of potatoes, tops and roots could be increased with the addition of sodium to the nutrient solution when potatoes are grown in water culture and that sodium could be used to replace a part of the potassium. In figure 3 the growth of potatoes is shown with and without sodium at six levels of potassium. The data indicate that a small amount of potassium can be replaced with sodium. Although conclusive results were obtained in the greenhouse, results obtained in the field were erratic and incomplete and at the present, field experiments to determine the rôle of salt in the nutrition of potatoes are still in progress.

FIG. 2. Growth of Triumph potatoes in water culture with two levels of potassium and with and without additions of sodium.
A—No potassium, no sodium added.
B—No potassum, 125 parts per million sodium added.
C—168 parts per million potassium, no sodium added.
D—168 parts per million potassium, 25 parts per million sodium added.

SUMMARY

Analyses of virgin and cultivated Northern Wisconsin soils show that when potatoes are grown on these soils for from 10 to 30 years the available phosphorus and soluble manganese content and acidity are increased while the available potassium, calcium, and magnesium contents are seriously depleted.

Field experiments have demonstrated that for broadcast application a 6-6-18 fertilizer has given higher yields, at 1200 pounds per acre, than have analyses with higher or lower nitrogen, phosphate or potash. These fertilizers were all applied with a uniform application of 3-12-12 in the row. Applications of more than 800 pounds per acre of fertilizer in the row were not beneficial. An average of experiments on nine fields in seven years shows that the application of 800 pounds of 3-12-12 in the row increased the yield, over the unfertilized, about 60 bushels per acre. The additional application of 1200 pounds of 6-6-18 gave a further increase of 80 bushesls.

Field, greenhouse, and laboratory tests show that when soils are

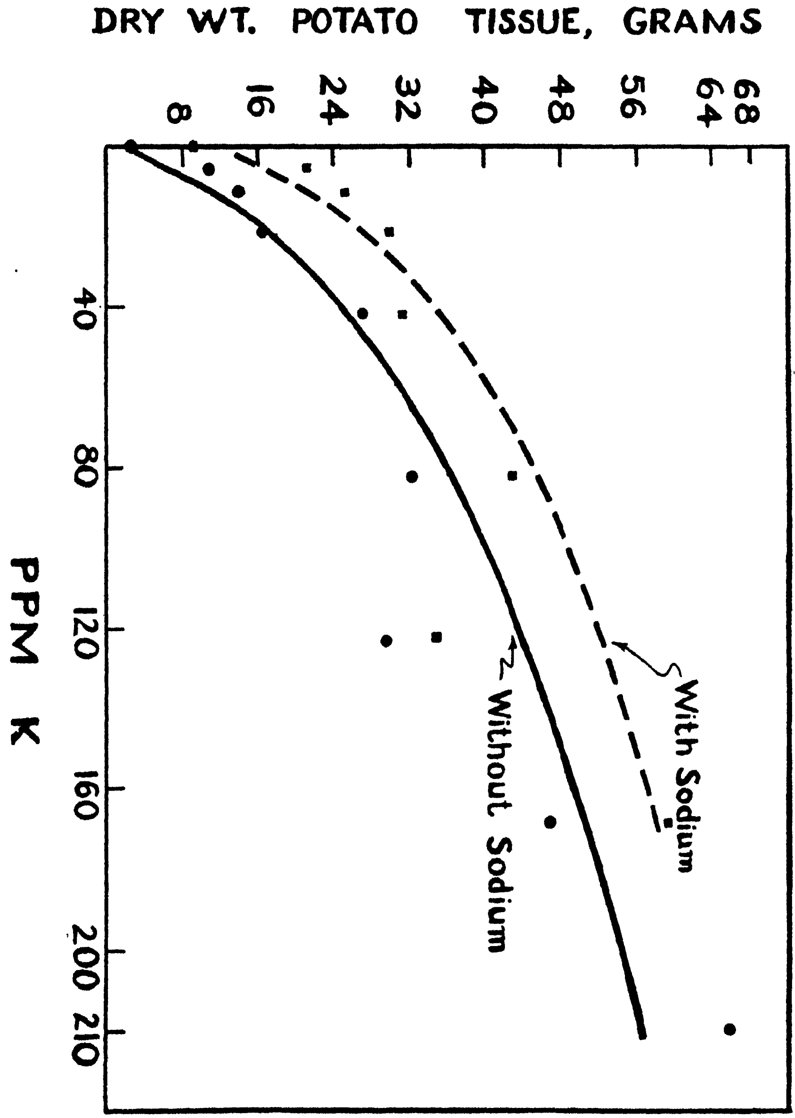

FIG. 3. Influence of sodium on dry weight of potato tops and roots produced in water culture. The amount of sodium added varied with the potassium present so that the total sodium and potassium was always equivalent to 210 p.p.m. of potassium.

below pH 5.0, finely ground dolomitic limestone should be applied to add available calcium and magnesium to the soil, and to reduce the excess amounts of soluble manganese present in some of these soils. It is often advisable to add some soluble magnesium in the fertilizer, in addition. Manganese toxicity, known as stem streak necrosis of potatoes, and magnesium deficiency are quite common on these soils.

In greenhouse experiments it was demonstrated that the addition of sodium to the nutrient solution, in which potatoes were grown, increased the dry weight of tops and roots when the potassium content of the solution varied from none to 210 parts per million. Consistent increases in yields were not obtained in the field, however.

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SECTIONAL NOTES

Michigan

The crop that is being harvested is in fine shape. The weather has been very favorable. Our yields, generally speaking, are above normal; and in some areas we have the highest yields we have ever harvested.

Our greatest problem is storage. Since the Michigan acreage was shifted to different areas of production, the storages in some areas are not being used. The new producing areas are short on storage, which makes it necessary to ship a considerable quantity of their stocks out before cold weather.

Our shipments to the government, at present, far exceed those shipments to the trade. Government shipments are used chiefly for alcohol and flour. It is generally thought that the government estimate on Michigan's crop is low.

It is too early to give any definite information on the Certified Seed situation, as our final inspection has not yet been completed.—H. A. Reiley.

New Jersey

The New Jersey potato crop is now harvested and despite the excessive rainfall in the spring, our yields have averaged higher than in any previous year. The U.S.D.A., in its October report, estimates the yield at 221 bushels per acre which is a 48 bushel increase above the average yield for the ten-year period 1937-1946. The quality of our potatoes has been very good but unfortunately many of these good potatoes have been converted into flour through the government price support program, leaving the commercial grade to be sold to the consuming public. This fact has led many consumers to think that New Jersey potatoes were inferior in quality.

Most of our growers believe that there must be a reduction in potato acreage throughout the country and perhaps the government plan to cut price support to 60 per cent of parity, is one method to accomplish this, but they definitely do not plan to cut their acreage by 33 per cent, as was recently suggested by the government. Such a large cut is unfair to any area that has complied with government regulations as closely as have the New Jersey growers, whereas other areas that have planted approximately twice their allotted acreage are given a smaller cut. Some of our growers feel that a price support of 60 per cent of parity would remove the ill feeling about price support current among some people, but they also believe that a new parity figure should be established taking into account the average yields per acre in the various areas.—J. C. Campbell.

New York

Potato harvest is in full swing with the largest average yield per acre ever reported. Because of the long growing season ending with dry weather, our quality is excellent.

Except in concentrated areas, growers are not utilizing the government program to move potatoes. Every storage will be filled to capacity and a lot of low grades will be utilized for cattle feed.

Reports of recent years where potatoes have been fed to cattle indicated excellent returns. The standard recommendation is to feed potatoes as a supplement rather than a substitute for any other feed. Cows appreciate the variety and respond accordingly.

The few processing plants we have in New York State are operating to capacity.

The Seed Potato crop, for the most part, is good. Seed growers have planted very close to keep size down and many growers have killed vines with chemicals, flame and roto-beaters. Virus diseases were lower

this season than has been the case for many years, and a relatively small percentage of the acreage will be turned down. With both good size and quality our seed growers are not anxious to move seed until spring.

The attitude of up-state potato growers generally in regard to the proposed 1949 Program is favorable. The proposed reduction in acreage is rather drastic on Long Island and there will be some objection to the cut there but many Long Islanders's have expressed the thought that they might get more money with considerably less acreage.—H. J. Evans.

North Dakota

North Dakota potato growers have just harvested the best crop of certified seed potatoes they've ever had and that's some record, for this state always ranks at the top in the production of seed potatoes. The quality is exceptional and the yield much greater than anticipated.

Ideal weather conditions both during the growing season and harvest contributed immensely toward making this a banner year in North Dakota's seed potato history. Dry, cool days over long periods developed the seed gradually to its maturity. The potatoes, when harvested, were bright, clean and smooth. More than 90 per cent of North Dakota seed potatoes are dry-land grown above the 47th parallel north which accounts for their unusual vigor.

One hundred of the certified seed potatoes are harvested now, according to R. C. Hastings, state seed commissioner. Ten per cent have already been marketed. The balance has been put in storage ready for future deliveries. The most popular varieties grown in North Dakota are Bliss Triumphs, Irish Cobblers, Red Pontiacs, Pontiacs, Red Warba, White Rose and Early Ohio. There are also some small acreages in various other new varieties, which have been planted for experimental purposes.—Grace Hudson.

Province of Ontario

Harvesting of the potato crop is now in full swing with conditions ideal. The quality of this year's crop in Ontario is exceptionally good. Although our tubers are somewhat larger than usual, there will be little loss from blight. There is a noticeable decrease this year in the amount of surface scab found in commercial areas, and in most cases, the tubers are well matured, with a smooth, clean, and attractive appearance.

Growers have substantially increased their mechanical equipment and a large number have acquired tractor driven power-take-off harvesting outfits, with picker attachments and in some cases, graders and load-

ers. They are preparing to supply a larger quantity of potatoes that are annually imported for consuming purposes in the Province.

Although the present prices to growers cannot be considered high, there is recently an increasingly firmer tone to the market. Growers, with poor quality potatoes and with low yields per acre, are finding that present prices do not pay production costs, and also that demands for potatoes which do not meet requirements of Canada No. 1 grade are very limited. Considering excellent outlets for meat and milk products, it is likely that large quantities of cull and off-grade potatoes will be utilized to good advantage on farms as livestock feed.

The present quotations on Toronto market are lower than any other large consuming center in the Province, and on the 7th of October were $1.25 to $1.35 per 75-lb. bag for a Canada No. 1 grade on a wholesale to retail basis. Arrivals from P.E.I. and N.B. this season to date have been practically *nil*. With our present and anticipated outlets for large quantities of Maritime stocks to U.S.A. and other export markets, together with the fact that price differential favors the purchase of Ontario potatoes, consumers are showing preference for the high quality local product, during these times of increased living costs for many commodities with the exception of potatoes.—R. E. GOODIN.

PROVINCE OF PRINCE EDWARD ISLAND

Our potato crop this year in Prince Edward Island has a total yield slightly below that of last year and is now being harvested in good condition. Only approximately 50 per cent of our crop is harvested as of the 8th of October but indications are that notwithstanding considerable blight in the fields, the farmer with good hilling and those who top-killed early, are digging a very sound crop.

A large amount of the seed this year is of Foundation A grade or better. The average yield is below that of last year but above our average.

Present indications are for a good demand for our seed from the Southern States of the United States for early fall, in fact from all parts of the states for late fall. It does seem possible that our large seed quota of 2½ million bushels to the United States will be filled by the first of January 1949.

Potatoes grown on the Island in order of volume are Irish Cobblers, Green Mountains, Sebagoes, Katahdins, and lastly a few Sequoias —only a total of 146 acres, and our total seed acreage is 30,000.—E. D. REID.

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A STUDY OF THREE FACTORS IN POTATO PRODUCTION: ROW SPACING, SEED SPACING, AND FERTILIZER RATE[1]

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Interest in determining experimentally the effects of different planting distances on the yield of potatoes goes back many years. It is a matter of historical record that some of the first field experiments reported by experiment stations in this country dealt with this problem (2, 5). The effects of different rates of fertilizer on potato yields likewise is a time-honored study. However, the combination of three ...ors —row spacing, seed spacing, and fertilizer rate—in one experi-

[1]Conducted under cooperative agreement between the Virginia Truck Experiment Station, V. A. Tiedjens, Director; and the Division of Fruit and Vegetable Crops and Diseases, U. S. Department of Agriculture. Acknowledgment is made to H. M. Clark, Superintendent, Eastern Shore Branch Truck Experiment Station (Virginia) for helpful assistance. The work was inaugurated with the help of the late Dr. H. H. Zimmerley whose genuine interest and sound judgment were always of great value to the writers.

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ment so that the individual effects of each might be determined concomitantly with their interactions is at least a new approach to an old problem and offers possibilities for evaluation peculiar to the factorial type of experimental design.

Stated briefly, the objectives of the experimental work here reported were to determine the effects of different seed and row spacings on yield and to measure concomitantly the extent to which seed spacing and row spacing might jointly affect yield production, and to determine also the effects of different amounts of fertilizer on yield, particularly in relation to the different planting distances. Since the three principal factors under study involved the use of different quantities of seed and fertilizer per acre, it seemed especially desirable to estimate the economy of the different planting procedures so that they might be compared on the basis of net returns "beyond" the cost of treatment.

After the first year's crop had been harvested a decision was made to measure also the experimental effects of the different variables on the average size of prime potatoes produced.

Experimental Procedure

The experiments were located on Sassafras sandy loam soil in the vicinity of Onley, Virginia. Although all the experimental fields were regarded as satisfactory for growing potatoes, the production capacity of the field used in 1943 was considered relatively low. The reaction of these soils at planting time ranged from pH 4.6 to 5.2. Each year the fields were planted about the 15th of March, using an assisted-feed potato planter equipped with band-placement fertilizer attachments. The fertilizer distribution mechanism on the planter was carefully calibrated each time before planting commenced in order to assure delivery of the fertilizer at the proper rates; and at the same time the seed-spacing adjustments were also checked. Certified Irish Cobbler seed was used and commercial 5-10-5 fertilizer, 95 per cent neutralized, containing 255 pounds of dolomitic limestone per ton.

The experimental field plan in 1943 consisted of what is generally called a split-plot arrangement. In this first field plan the row spacings, 30 and 36 inches, occupied the main plots and randomly arranged on these were three seed spacings, 10, 15, and 20 inches, and three fertilizer rates, 1,500, 2,000, and 2,500 pounds per acre. However, in 1944 the field plan was changed to a so-called double split-plot arrangement which was used also in 1946. The treatments remained the same in this plan except that the widest hill-spacing distance was reduced to 18 inches, and the fertilizer rates were laid out as main plots, the row spacings as sub-plots, and the seed spacings as ultimate plots.

In the analysis for the latter experimental design three error terms were calculated, one for testing each main effect and its interactions. When planted, the individual plots consisted of 3 or 5 rows 80 feet long, but at harvest in order to eliminate differential spacing effects, the 2 outside rows were discarded. Four replications of each treatment were provided and these, arranged in randomized-block fashion, comprised a total of 72 plots for the entire experiment. In 1945 due to extremely abnormal weather conditions occurring shortly after planting, the growth of the crop was so irregular that the entire experiment had to be discarded, and consequently there are no records for that year.

Results

Effects on Yield and Net Returns

The yields obtained for the 3 experimental years in bushels of primes graded for size only are shown in table 1. In addition, the net returns "beyond" the estimated cost of seed or fertilizer[4] for the stated experimental variables are also given. It will be noted in table 1 that the differences in yield obtained from the two row spacings produced significant variance only in 1946. In that year the rows spaced 36 inches produced an average increase of 41.1 bushels of primes over the 30-inch rows, exceeding the least significant difference for the 1-inch per cent point. This outstanding difference in yield in 1946 may be partly attributed to the early maturity of the vines on the 30-inch row plots, which in every case matured a week to 10 days earlier than those on the 36-inch row plots, thus affording a relatively longer growing period for the plants on the wider-spaced rows. This difference in time of maturity was not observed in 1943 or 1944.

The different seed-spacing distances, on the other hand, had sufficient effect on yields, as is shown in table 1, to produce significant variance each year, but the levels of significance attained in 1943 were higher than in 1946. When a comparison of the variance produced by each of the three factors under study was made, it was evident that seed spacing had a relatively more pronounced effect on yield than had row spacing or fertilizer rate. In general, the yields were increased when the seed was spaced closer, but these increases were not always significant, nor were they always economical from the standpoint of the additional seed required, as will be brought out later.

One exception to the general tendency toward increased yields with closer seed spacing occurred in 1946 when the 10-inch spacing

[4]From these net returns beyond the cost of seed or fertilizer obviously must be deducted all other production costs to arrive at the real net gains, but we are not specifically concerned with these here.

TABLE 1.—*Effect of row spacing, seed spacing, and fertilizer rate on the yield of prime potatoes and on the net returns "beyond" the cost of seed or fertilizer.*

Treatment	1943 Yield	1943 Net Returns[1]	1944 Yield	1944 Net Returns[1]	1946 Yield	1946 Net Returns[1]
	Bushels	Dollars	Bushels	Dollars	Bushels	Dollars
Row spacing:	[2]—	[3]	—	[3]	**	[3]
30-inch	124.5	102.10	155.6	138.22	206.3	199.06
36-inch	115.7	99.59	190.8	188.66	247.4	256.58
L.S.D. .05	—		—		21.1	
.01	—		—		30.3	
Seed spacing:	**	[4]	**	[4]	*	[4]
10-inch	134.2	101.19	202.1	182.67	218.7	202.59
15-inch	121.8	106.11	180.8	176.91	235.5	242.55
18-inch[5]	104.4	95.35	178.3	180.66	226.3	238.26
L.S.D .05	9.9		13.0		12.3	
.01	13.5		17.4		16.6	
Fertilizer rate:	**		—		—	
1,500 lbs.	128.9	127.68	178.1	186.72	208.8	223.56
2,000 lbs.	123.4	112.08	189.6	191.52	246.8	260.16
2,500 lbs.	108.2	84.84	193.6	187.32	224.9	224.88
L.S.D. .05	9.9		—		—	
.01	13.5		—		—	

[1] Net returns "beyond" the cost of seed or fertilizer (potatoes at $1.20 and seed potatoes at $3.00 per bushel; fertilizer at $36 per ton).

[2] Variance for factor indicated: —, not significant; *, exceeded 5-per cent point; **, exceeded 1-per cent point.

[3] Average seed spacing 15 inches, 1-ounce seed piece.

[4] Average row spacing, 33 inches, 1-ounce seed piece.

[5] In 1943, 20-inch.

produced a lower average yield than either of the two wider seed spacings as shown in table 1. The yields produced by the 15-inch-spaced seed, however, were greater each year than those from the wider seed spacings, and in 2 out of 3 years (1943, 1946) the net returns were also greater. Further decreasing the seed spacing distance from 15 to 10 inches, in the two years mentioned, reduced the net returns obtained. Although 10-inch-spaced seed gave an increased yield of 12.4 bushels over 15-inch spacing in 1943, exceeding the 5-per cent point, the estimated net returns were reduced $4.92, at the price differentials stipulated. These comparisons are of interest because they illustrate the need for considering cost relationships in evaluating the differences in yields obtained where a cost differential is involved.

The three fertilizer rates produced significant yield variance only in 1943. In that year, which was dry, the average yield obtained from the 2,500-pound rate was significantly lower than that from either 1,500 or 2,000 pounds, and as a result the net returns were also sharply reduced. In 1944, also a dry year, the 2,500-pound rate, although showing a slight increase in yield as compared with 2,000 pounds, nevertheless produced about the same net returns as those from 1,500 pounds. In 1946 the 2,500-pound rate again produced a lower average yield and smaller net returns than the 2,000-pound rate. These latter comparisons, although interesting, are open to question statistically, since the variance for fertilizer rates was not significant in 1944 or in 1946.

A comparison of the results from the 30- and 36-inch row spacings (table 1) shows that in 1944 and 1946 the 36-inch spacing gave higher yields and larger net returns than the 30-inch spacing, even though the growing conditions differed during the two seasons and noticeably affected the absolute yields obtained. In 1946, the difference in favor of the wider row spacing amounted to 41.1 bushels and $57.52 estimated net returns per acre. The same comparisons in 1944 show increases of 35.2 bushels and $50.44 per acre for the wider row spacing. In 1943, however, the 30-inch spacing gave a slightly larger average yield (8.8 bushels) and an increase of $2.51 in net returns above that of the 36-inch spacing. However, it should be pointed out that this apparent increase in net returns was offset to some extent by the reduction of 16⅔ per cent in the number of rows worked at the 36-inch spacing. Although the differences obtained between the two-row spacings in 1943 and 1944 are of interest, no statistical significance is attached to them since the variance for row spacing in these years did not reach the 5 per cent point.

Profits from Investment

From table 1 it will be noted that the maximum gross returns from seed use did not always indicate a proportionately large net return "beyond" the cost of seed. In 1943 net returns from the three seed spacings were not appreciably different although there was a maximum range of about 16 per cent in the gross returns from 10-inch- and 20-inch-spaced seed. These results bring out very clearly the fallacy of using gross returns alone as an indication of returns on investment for seed or fertilizer.

Profit is a function of both efficiency and economy of production, and the only valid measure of profit is the net returns per acre "beyond" the cost of investment. To attempt to increase efficiency at the expense of net returns would soon make the enterprise unprofitable. Conversely, to attempt to increase yields at the expense of efficiency in the use of fertilizer or seed would ultimately reduce the rate of profit. Insofar as seed potato use and fertilizer rates are concerned the most profit will be realized from that combination which produces the largest net return "beyond" the cost of both seed and fertilizer. Although it is often tacitly assumed that high potato yields, indicating efficient production and economical land use, are the most profitable, yet a valid estimate of real net profit from such a venture cannot be obtained until the increased cost of seed, fertilizer, labor, and all other production costs required are charged against the selling price of the crop. Increases in yield caused by highly favorable weather conditions are, however, almost clear profit except for the additional handling costs; but yield increases obtained by using more seed or fertilizer if carried far enough will inevitably lead to a point in production where profits will be reduced by the operation of the law of diminishing need (4) and its complement the law of diminishing returns.

Although the net-return figures in table 1 are based on estimated costs of seed potatoes and fertilizer, as well as on an estimated price for No. 1 potatoes, small changes in these estimates will have little relative effect on the net-return values. It will also make little difference under many conditions whether total yields or only yields of No. 1 potatoes are used because the gross returns must then be adjusted for field-run price, which will be lower than that for No. 1 potatoes. In the present experiments the highest estimated returns "beyond" the cost of seed were obtained from the 15- and 18-inch spaced seed in rows 36 inches apart.

Assuming an estimated cost of fertilizer at $36.00 per ton and the selling price of potatoes at $1.20 per bushel, the largest net returns per

acre "beyond" the cost of fertilizer for the 3 years were obtained from the 2,000-pound rate. Increasing the rate to 2,500 pounds per acre reduced the estimated net returns obtained each year. The point at which the net returns per acre "beyond" the cost of fertilizer begin to diminish obviously will depend on several factors, among them the ability of the crop to utilize the additional fertilizer (law of diminishing need); the kind of land and the growing conditions; the cost of the fertilizer; the selling price of potatoes; and above all the judgment and ability of the grower. For these reasons, and there may be others, the upper limits for profitable fertilizer use (maximum net returns from fertilizer) can vary from farm to farm and even from field to field. It is advisable, therefore, to determine these limits actually over a period of years on the land in question wherever possible.

Interactions

From the standpoint of yield, all the various interactions between the three factors studied failed to attain statistical significance, except that for seed spacing x row spacing in 1943 as shown in table 2. These data indicate that in 1943 the row spacings had very little effect on yield with seed spaced 10 or 15 inches apart, but that a highly significant reduction in yield resulted when the row spacing was increased from 30 to 36 inches with seed spaced 20 inches apart. The latter effect undoubtedly accounts for a large part of the reduction in yield obtained for 20-inch seed spacing in 1943 as indicated in table 1. In general, the net returns "beyond" the cost of seed planted as shown in table 2 followed the same trends for row spacing and seed spacing that was obtained during the 3 years, except that the 20-inch spacing with 36-inch rows produced an unusually large reduction in net returns per acre, as might be expected from the corresponding reduction in yield.

Economies in Seed Use

Although the effects of seed spacing and fertilizer use on yield and net returns per acre "beyond" the cost of seed or fertilizer should be determined, if possible, under local growing conditions, there are, however, certain fixed relationships between planting distances and efficient seed use that remain the same regardless of location. Although expenditures for seed constitute an important item in production costs, it is not always fully recognized that slight changes in planting distances that may appear insignificant can have marked influence on the amount of seed potatoes required per acre. It is true that the size of seed piece used will have a direct effect on the amount of seed required per acre,

TABLE 2.—*Effect of interaction row spacing x seed spacing on the yield of prime potatoes and on the net returns "beyond" the cost of seed, 1943.*[1]

Row Spacing		Speed Spacing					
		10-inch		15-inch		20-inch	
		Yield	Net Returns[2]	Yield	Net Returns[2]	Yield	Net Returns[2]
		Bushels	Dollars	Bushels	Dollars	Bushels	Dollars
30-inch		135.2	96.84	121.8	102.36	116.6	107.22
36-inch		132.2	105.66	121.8	109.86	92.1	83.37
L.S.D.	.05	14.1		14.1		14.1	
	.01	18.8		18.8		18.8	

[1]Variance of interaction exceeded 5-per cent point.

[2]Net returns "beyond" the cost of seed (potatoes at $1.20 and seed potatoes at $3.00 per bushel).

but the effect of changes in the planting distances can be even greater. In the present experiments, for instance, widening the row spacing from 30 to 36 inches reduced the seed requirements 16⅔ per cent. On the other hand, widening the seed spacing produced even greater economies in seed use—10 inch to 15-inch, a 33⅓ per cent reduction; 15-inch to 18-inch, 16⅔ per cent; and 10-inch to 18-inch, approximately a 45 per cent reduction. However, by increasing both row spacing and seed spacing even greater effects on seed economy can be attained. For example, changing from 30-inch rows with seed spaced 10 inches apart to 36-inch rows with seed spaced 15 inches apart would effect a reduction of 44.5 per cent in seed required, and with 18-inch seed spacing the reduction would amount to about 54 per cent of the original seed requirement at the closer planting distances. In evaluating the effectiveness of different potato planting distances, therefore, proper consideration should be given to these seed-use differentials. This can be accomplished by calculating the net returns per acre "beyond" the cost of seed in each case.

Effect on Size of Prime Tuber

The effects of the three main factors, seed spacing, row spacing, and fertilizer rate, on the average weight of prime potatoes produced are presented in table 3. It will be noted that the variance for each of the three main factors was highly significant every year except that for fertilizer rates in 1946. The average weight of prime tubers from rows spaced 36 inches apart was 10.9 grams heavier in 1944 than that from 30-inch rows, and in 1946 this increase amounted to 18.9 grams. In both years the increases were highly significant. A similar effect on size of tuber was obtained when the seed spacing distance was widened. Increasing the seed spacing from 10 to 15 inches produced a highly significant increase in the average size of tuber both in 1944 and 1946. However, further increasing the seed spacing from 15 to 18 inches produced smaller increases in weight of prime tubers statistically significant only in 1946. The variance from the interaction of the two factors (seed spacing x row spacing) was not significant either year, indicating therefore that they were acting independently in their effects on size of tuber.

The average weight of prime potatoes was also affected by varying the fertilizer rate from 1,500 to 2,500 pounds per acre, but this effect was not quite so pronounced as that obtained by varying the row or seed-spacing distances. This is in agreement with the results of Chucka *et al.* (1) who found the effect of seed spacing much more pronounced than that of fertilizer rate on the number and weight of U. S. No. 1

TABLE 3.—*Effect of row spacing, seed spacing, and fertilizer rate on the average weight of prime tubers produced.*

Treatment		Average Weight of Prime Tubers Produced	
		1944	1946
		Grams	Grams
Row spacing:		**[1]	**
30-inch		146.3	109.0
36-inch		157.2	127.9
L.S.D.	.05	7.5	5.5
	.01	10.8	7.8
Seed spacing:		**	**
10-inch		137.9	105.6
15-inch		156.0	120.5
18-inch		161.3	129.2
L.S.D.	.05	7.3	7.4
	.01	9.8	8.9
Fertilizer rates:		**	—
1,500 pounds		141.8	114.5
2,000 pounds		152.1	124.5
2,500 pounds		161.2	116.3
L.S.D.	.05	9.2	—
	.01	14.0	—

[1]Variance for factor indicated: —, not significant; *, exceeded .05 point; **, exceeded .01 point.

potatoes produced in Maine. The variance from fertilizer rates, it will be noted, was significant only in 1944. In that year the 2,000-pound fertilizer rate increased the average weight of prime tubers 10.3 grams over the 1,500-pound rate, and an additional increase of 9.1 grams was obtained with the 2,500-pound rate. Similar increases were obtained in 1946 for 2,000 pounds of fertilizer; but the 2,500-pound rate produced a marked reduction in size of tuber, which undoubtedly helps to account for the reduction in yield for this particular fertilizer rate in table 1, column 6. Apparently the size of tuber and the yield were affected similarly in this case.

INTERACTIONS

The interaction seed spacing x fertilizer rate was the only one that attained significance in 1944. This interaction, however, was not significant in 1946; that year row spacing x fertilizer rate was the only interaction with variance exceeding the 5-per cent level of significance. The data pertaining to these two interactions are given in tables 4 and 5.

TABLE 4.—*Effect of interaction seed spacing x fertilizer rate on average weight of prime tubers in 1944.*[1]

Fertilizer Rate	Seed Spacing and Average Weight of Prime Tubers		
	10-inch	15-inch	18-inch
	Grams	Grams	Grams
1,500 pounds	129.0	155.3	141.2
2,000 pounds	135.2	154.8	166.3
2,500 pounds	149.5	157.7	176.3
L. S. D. .05—12.7 grams .01—15.9 grams			

[1]Variance of interaction exceeded .01 point.

TABLE 5.—*Effect of interaction row spacing x fertilizer rate on average weight of prime tubers in 1946.*[1]

Row Spacing	Fertilizer Rate (pounds per acre) and Average Weight of Prime Tubers		
	1,500 Pounds	2,000 Pounds	2,500 Pounds
	Grams	Grams	Grams
30-inch	103.5	110.8	112.6
36-inch	125.5	138.2	120.0
L. S. D. .05— 9.3 grams .01—13.3 grams			

[1]Variance of interaction exceeded .05 point.

It is clear from the results in table 4 that the wider seed spacing generally increased the average weight of tuber but there is also an indication that this effect was more pronounced at the two higher fertilizer rates. In the case of the 1,500-pound fertilizer rate the average tuber weight with 18-inch spaced seed was actually lower than that obtained with 15-inch spacing. Apparently the 18-inch spacing was too wide to enable the crop to make the best utilization of fertilizer at the lowest rate. For each additional 500-pound application of fertilizer above the 1,500-pound rate, the average weight of prime tubers was increased appreciably with 10-inch and 18-inch seed spacings. However, this effect of fertilizer, for some non-apparent reason, was not obtained with the 15-inch seed spacing.

The influence of the interaction row spacing x fertilizer rate on the average weight of tubers presented in table 5 may be ascribed to the effect of 30-inch rows in consistently producing smaller tubers than those from the 36-inch rows, but to an extent which was more pronounced at the two lower fertilizer rates. These interaction results in tables 4

and 5 lead to the conclusion that the effects of the seed and row spacings for the years indicated were not independent of the changes in fertilizer rates.

Discussion

It is recognized, of course, that the adoption of certain cultural practices such as those calling for wider row or seed spacings, which have a tendency to increase the size of tuber, may have the undesirable effect of unduly increasing tuber size with certain varieties under some growing conditions. However, under the experimental conditions prevailing in 1944 and 1946 this did not take place since the average weight of prime tubers ranged from 104 to 176 grams (3.7 to 6.2 ounces). These figures may be compared with 61 grams (2.1 ounces), which was found by the writer (3) to be the minimum weight of a prime-sized potato (Irish Cobbler). As far as the present experiments are concerned the width of rows and the spacing distance of seed have been shown to act independently on the individual weights of primes so that both factors should be considered of equal importance in their influence on the size of potatoes produced.

That the best yields of potatoes were not dependent upon any one of the specific combinations of fertilizer rate and seed spacing studied is indicated by the fact that the interaction seed spacing x fertilizer rate was not significant for any of the three experimental years. From the standpoint of yield and of net returns, however, the 15-inch seed spacing and the 2,000-pound fertilizer rate combination was the most outstanding. Also, from the same standpoint the 36-inch row spacing was somewhat superior to the 30-inch spacing, but further statistical evidence would be required to establish this result conclusively.

Because of the variability in the results that occurred from year to year, consideration was given to the possibility of obtaining a better estimate of residual error through pooling the yields for the 3 years. This procedure was rejected, however, when the error variances for the main effects were found to be non-homogeneous by the chi-square test. This result ordinarily would be expected since a 3-year period is usually too short to provide an adequate sample of seasonal variation from the standpoint of yields produced. Nevertheless, the unique features of the factorial experimental design permit an interesting evaluation of the individual yearly results as main effects and interactions.

In actual practice, potato growers undoubtedly will want to determine the best combination of seed spacing, row spacing, and fertilizer rate for their own local conditions, but in doing this they should not

underestimate the importance of the economic considerations involved. The yields or gross returns obtained by arbitrarily increasing the amounts of potato seed or fertilizer used will ultimately reach a production limit for any set of growing conditions. The type of gross returns curve obtained under any specific combination of cost-price relationships of seed, fertilizer, and potatoes will in turn determine the point of maximum net returns "beyond" cost and will likewise set the pattern for the operation of the law of diminishing returns. Any potato-growing venture will in a large measure depend upon these important economic and production factors for its financial success.

Summary

Field experiments were conducted in 1943, 1944, and 1946 at Onley, Virginia, to study three factors in potato production: row spacing, seed spacing, and fertilizer rate.

A factorial field design was used which made possible the evaluation of main effects and interactions for 30- and 36-inch row spacings, 10-, 15-, and 18-inch seed spacings, and 1,500-, 2,000-, and 2,500-pound fertilizer rates. These effects were determined on yield and size (weight) of prime tubers.

The results from the three variables were also evaluated on the basis of the net returns per acre "beyond" the cost of seed or fertilizer.

Yields of primes were generally increased when the seed was spaced closer, but these increases were not always significant nor were they always economical from the standpoint of the cost of additional seed required. Of the three factors studied, seed spacing was found to have the greatest influence on yield, acting independently of row spacing except in one year.

The largest financial returns "beyond" estimated cost of seed and fertilizer were realized from seed spaced 15 or 18 inches in rows 36 inches apart and from the 2,000-pound application of fertilizer.

The average weight of prime tubers was increased when the seed was planted either farther apart in the rows or when the rows were spaced wider. These two factors were found to operate independently on size of tuber. The effect of varying the fertilizer rate on the size of tuber, however, was less pronounced than the effect from changes in the planting distances. Nevertheless, in 2 of the 3 years there was some indication from the interactions obtained that the effects of row spacing or of seed spacing were not independent of the amount of fertilizer applied.

Attention is called to the importance of making local tests to de-

termine, under the prevailing growing conditions, the most profitable planting distances for the particular potato variety used and the most profitable rate for the kind of fertilizer applied.

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CHROMATES AS POTATO FUNGICIDES[1,2]

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Recent announcement[6] of copper zinc chromates as foliage fungicides for potatoes is of special interest since materials of this type are probably the only new inorganic chemical compounds to show promise in this field in recent years. These chromates are complex chemical entities whose solubilities are of such a nature that solubility characteristics may be used to control the uniformity of the product, so far as fungicidal action and phytotoxicity are concerned. In addition they have very definite X-ray patterns which are used further to control the uniformity of the product. The chromate is a greenish-yellow free-flowing powder, of low water solubility. It is 100 per cent active, readily suspendible and presents no problems of handling or 1 use in the field.

Field tests with numerous chromates have been conducted for a number of years and tests on potatoes as early as 1942 demonstrated

[1]The field work on which this report is based was conducted in part with funds supplied by Carbide and Carbon Chemicals Corporation—through the Crop Protection Institute.

[2]Authorized for publication in the Journal Series of the Penna. Agr. Exp. Sta. Published also with the approval of the Director, West Va. Exp. Sta. as scientific paper No. 394.

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[6]Phytopathology 38:27, Jan. 1948.

that with suitable proportions of zinc in the complex there was better control of tip burn than could be obtained with simple copper chromates or other forms of copper fungicidees. This was probably due to the control of leaf-hoppers. Rather large quantities (six pounds per 100 gallons) were required to obtain yields equal to or better than that Bordeaux (8-8-100).

For disease control, however, the field tests showed that a dosage of only 2 pounds per 100 gallons of a copper zinc chromate having suitable proportions of the metals (approximately 3, copper: 2, zinc: 1.2, chromium) could satisfactorily be used on potatoes. D.D.T., which is now generally accepted as a suitable insecticide for use on potatoes is compatible with the copper zinc chromate and is used in such proportions as may be necessary for insect control.

Two years of field tests with copper zinc chromate complexes of this type are reported here in comparison with other, better known, fungicides. These tests involved several varieties of potatoes and were conducted in three different states and in situations where early blight *Alternaria*, or late blight, *Phytophthora*, or both were important factors in affecting yields. In all tests D.D.T. was used in all plots including the check.

TABLE 1.—*Average yield in bus. per acre—Pennsylvania and West Virginia*—1946.

	Pennsylvania Russets	West Virginia Cobblers
Check	138	122
Bordeaux	227	179
Dithane	202	178
Tribasic	219	227
Copper Zinc Chromate	202	232

TABLE 2.—*Average yield in bus. per acre—Ohio*—1946

	Wooster	Marietta	McGuffy
Check	220	219	389
Bordeaux	365	491	548
Zerlate	414	498	540
COCS	356	481	563
Copper Zinc Chromate	381	493	583

It is of interest in 1946 that the copper zinc chromate produced the higher yield in two of the five trials reported (once in West Virginia and one in Ohio), whereas Zerlate was higher in two of the Ohio trials and Bordeaux in one, (on Russets in Pennsylvania).

TABLE 3.—*Correlation between late blight ratings and control yield.*

	1946 West Virginia	
	Rating	Yield
Check	119	122
Bordeaux	85	179
Dithane	84	178
Tribasic	57	227
Copper Zinc Chromate	43	232

Late blight was severe in West Virginia in 1946, and table 3 shows an interesting correlation between a late season rating of the plots for blight control and the yield obtained.

TABLE 4.—*Average yield in bus. per acre—Pennsylvania and West Virginia.*—1947.

	Pennsylvania		West Virginia	
	Russet	Katahdin	Cobbler	Sebago
Check	243	318	312	320
Bordeaux	315	363	293	300
Dithane	341	377	265	326
Parzate	339	374	—	—
Tribasic	328	382	297	242
Copper Zinc Chromate	320	390	324	307

TABLE 5.—*Average yield in bus. per acre—Ohio*—1947.

	Wooster	Marietta	McGuffy
Check	354	365	644
Bordeaux	455	491	815
Dithane	473	540	854
Parzate	453	502	826
Tribasic	494	496	789
Par. Alt. Zer.	550	566	844
Copper Zinc Chromate	518	586	806

In 1947, similar tests in the same areas showed copper zinc chromate to have produced the highest yields in three trials out of seven. Dithane also rated 3 top places and an alternating schedule of Parzate and Zerlate took the top yielding position once.

In the thirteen trials reported above one of the worst outbreaks of early blight was that which occurred at Marietta, Ohio, in 1947.

Table 6 gives some indication of the relationship between successful control of early blight and yield.

Many new fungicides have appeared in recent years, especially organic fungicides of the dithio carbamate group. The widespread accept-

TABLE 6.—*Correlation between early blight control and yield.*

	1947, Marietta, Ohio	
	Per cent Alive	Yield
Check	30	365
Bordeaux	55	491
Dithane	57	540
Copper Zinc Chromate	76	586

ance of D.D.T. and its use on potatoes would seem to have brought back into competition several materials which previous to D.D.T. had merely been "also rans." The potato grower today is often confused at the multiplicity of materials offered him. Copper zinc chromate adds to the list, and it is not to the confusion. Such data as have been obtained would indicate this material to be the most promising new inorganic potato fungicide introduced in recent years.

EUROPEAN METHODS FOR THE UTILIZATION OF POTATO STARCH FACTORY WASTES

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INTRODUCTION

In the course of a survey made in the summer of 1947 to determine European practices for the industrial utilization of white potatoes, some information was obtained on methods of utilizing the waste pulp and protein water from white potato starch factories.

Although no experiments have been made at this laboratory to determine the feasibility of the methods mentioned here, the information is nevertheless presented at this time because of current surpluses of white potatoes and the fact that the problem of waste disposal has already become serious in Maine potato starch-producing areas. It is hoped that the ideas presented may serve as a basis for study of this problem. They will be given consideration in the work at this Laboratory.

NATURE OF WASTES

The fluid wastes from a potato starch factory consist of a large amount of water containing dissolved proteins and sugars and small

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amounts of suspended starch and fiber. In Europe the potatoes used for starch manufacture contain, on the wet basis, about 18-½ per cent starch and from 2 to 2.5 per cent protein. About 0.13 pound of protein per pound of starch produced is lost in the watery wastes of a starch plant. This protein is in such low concentration in the combined effluents from a starch plant that its recovery would be quite out of the question.

It would have to be recovered at the steps in the process where it is most concentrated, for example, in the effluent from the protein water separator.

The potato pulp, with a moisture content of approximately 96 per cent is separated during the screening operations. The pulp can be diverted from the screens, and pressed and dried to make a feed supplement by the methods described here.

Recovery and Utilization of Wastes

What is perhaps the cheapest way to eliminate stream contamination and at the same time utilize part of the fluid factory wastes is to spray them on the fields after the potatoes have been harvested. Obviously this procedure would not be practical in hilly country. However, it is used with considerable success in Holland.

A 6-inch header is run from the factory into a field, and the effluents are pumped into this header at a pressure of 250 pounds per square inch. The header is provided with plugs so that branch headers with six outlets each can be attached successively at different points. These outlets are hose nozzles set at about 45° and arranged to rotate or oscillate. The effluent is sprayed on the area until the water on the ground is about 1 inch deep, and is then discharged on another area. For example, if three nozzles, each covering an area of 3,600 square meters, spray a total of 70 cubic meters of effluent in one hour, the total depth on 10,000 square meters (1 hectare) would be about 0.7 centimeter. Such an arrangement would thus have to be shifted about once every three hours to cover the ground to a depth of one inch. This does not allow for any absorption by the soil. Hence, the interval would actually be in excess of three hours. Likewise, a heater with six nozzles handling the same amount of effluent (70 cubic meters per hour) and covering double the area, would have to be shifted about once every six hours.

The spraying is done after the harvest, and the following spring, potatoes are planted on the sprayed field. Attempts to flood the fields without using spray has resulted in unequal distribution of the fertilizing elements and is not considered practicable. After the water has filtered

through about 2 feet of soil it is pure enough not to cause serious contamination of the canals.

Protein Recovery

Protein is not generally recovered in France or Holland. In Germany, however, where attempts were made to achieve a self-sufficient economy, this problem has been extensively studied.

The European practice, especially in Germany, is to remove the protein water from the freshly ground potatoes by diluting the slurry and passing it through either a Jahn or Uhland continuous centrifugal prior to removal of the pulp by screening. In the United States this is sometimes done, but more frequently removal of the pulp precedes removal of protein water. In either case, the effluent coming from the protein water, centrifugal separator generally contains about 1 per cent dissolved solids, about one-half of which is protein. The potato itself contains from 2.2 to 2.5 per cent protein. The low protein concentration in the centrifugal effluent results from diluting the ground potato with from 4 to 5 times its weight of water, which is necessary to achieve good protein removal. The various methods of protein recovery described here apply to these centrifugal effluents. It has been reported, however, that the Jahn Company has developed an improved centrifugal which would remove protein effectively without such high dilution of the slurry. Effluents with a protein content of approximately 2.8 per cent have been reported, but this seems questionable, as it would indicate the use of much less than an equal volume of dilution water per volume of ground potato.

One method reported to have been used on a commercial scale is to evaporate the protein water under vacuum at 45°C. to a concentration of about 48 per cent solids, that is, 35° Baumé. Forced circulation, single-effect evaporators are used. The liquid concentrate becomes extremely thick when cold. It is therefore discharged hot from the evaporator and mixed with dewatered potato pulp and then dried for feed. Büttner scraper-type dryers of the design employed for drying starch handle this product satisfactorily.

A procedure for recovering part of the protein to produce a product suitable for the enrichment of soups consists in carrying the vacuum evaporation only to between 15 and 18° Baumé. The concentrate is then removed from the evaporator and heated to 80°C. for approximately one hour. This causes the higher molecular weight proteins to precipitate. This precipitate is reported to be easily filterable in an ordinary plate and frame filter press. The dried product contains 75-80 per cent protein. About half the protein in the concentrate from the evaporator remains

in solution. The filtrate is therefore returned to the evaporator and mixed with incoming protein water.

Other experimenters found that the precipitate obtained by this procedure was difficult to filter and had to be recovered with a solid bowl centrifugal. In this case the product was mixed with pressed pulp and dried for feed. The feed had the following analysis on a moisture-free basis: 20 per cent protein, 45 per cent starch, and 35 per cent fiber.

Methods based on precipitation of the protein recover only approximately 50 per cent of it. A method which recovers all of it consists in evaporating the protein water under vacuum at a temperature of less than 45°C. in order to avoid precipitation and carrying the evaporation to nearly 65 per cent solids. It is then spray-dried. The product is a dark-brown powder with a salty, agreeable flavor and has been reported to contain about 45 per cent protein. It has found some use in soups.

It is questionable whether any of these methods would prove profitable as a source of protein, but one or more of them might be justified on the basis of reducing stream contamination.

Pulp Recovery

In small potato starch factories the wet pulp is frequently accumulated in pits, from which it is hauled to local farms for hog feed. In the larger plants in Germany, Holland and France, however, the pulp is dewatered (with or without liming), usually in roller presses of the Büttner type, and is then dried. Drying can be done in steam tube dryers; in Büttner scraper-type dryers of the type used for starch; in direct heat, parallel-flow, high-temperature dryers; and in blast-type flash dryers. From 2 to 6 per cent of the original weight of the potato is obtained as pulp. The product usually contains about 6 per cent protein and 40 per cent starch on a moisture-free basis. It is used for cattle feed either by itself or mixed with recovered protein.

There seems little question but that pressing and drying pulp would be a desirable operation in our starch plants. The process is simple, and the value of the product as a feed should exceed the cost of preparing it. Information on processing potato pulp for feed may be found in AIC-204, "Recovery and Utilization of Pulp from White Potato Starch Factories." This was recently published by the Bureau of Agricultural and Industrial Chemistry and may be obtained from the Eastern Regional Research Laboratory, Philadelphia 18, Pennsylvania.

OFF-FLAVOR OF POTATO TUBERS PRODUCED BY BENZENE HEXACHLORIDE USED FOR WIREWORM CONTROL

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AND
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In testing benzene hexachloride for insect control the problem of taste contamination of food products has arisen. Benzene hexachloride may be used for control of some insects without regard to any taste contamination but taste must be considered in its use for control of wireworms on potatoes. This material has been reported promising or as very effective in wireworm control on potatoes by Greenwood (1947), Pepper, *et al* (1947), and Wolfenbarger (1948). Each of these writers has mentioned the off-flavor of tubers from benzene hexachloride treatments. They admited some off-flavor but indicated that most people did not detect flavor impairment when small amounts of the insecticide were used. A consideration of different amounts of benzene hexachloride applied per acre as related to the off-flavor tasted by different people is presented here.

The constituent of benzene hexachloride causing the off-flavor is as yet not fully understood. It is suspected of being one of the isomers, alpha, beta, or delta. The gamma-isomer is the most effective insecticidal constituent of crude benzene hexachloride. Refined materials, having high gamma-isomer content and an absence or reduced content of the other isomers have been prepared, which it was hoped might eliminate the off-flavor. Some degree of success may have been attained with the refined "high gamma content" benzene hexachloride but further tests are in progress to determine any improvement.

Some people seem to taste the benzene hexachloride contaminant in much more minute quantities than others. This has been termed "threshold," or "minimum stimuli" by Moncrieff (1946), and is an expected occurrence. Part of the taste detection comes from previous experience in handling or testing the material. Some who never experienced the odor of benzene hexachloride have simply detected an objec-

[1]Florida Agricultural Experiment Stations.
[2]Cornell University Agricultural Experiment Station.

tionable taste in products treated with it. In any event, rejection of certain commercial lots of food products has been experienced, caused apparently by the off-flavor imparted to plant products by benzene hexachloride treatments.

Materials and Methods—The tubers used for the tests reported here were taken from field experiments in which soil and potato seed pieces had been treated with crude, unrefined benzene hexachloride as reported by Wolfenbarger (1948). Several tubers were taken from each lot for tasting. The unpared tubers were washed and boiled in water, and then they were placed on tables for the tasters to sample. Non-professional tasters, mostly experiment station, college and university personnel, were used in the tests, although graduate students, growers, and others comprised a minor portion of the tasters. Each taster was asked to taste one or more tubers in each lot and to place it in one of the three classifications, as follows: (1) the ordinary or unimpaired potato flavor, (2) questionable flavor, and (3) a positive or definite off-flavor. Three groups of people in three different locations did the tasting, each under the direction of one of the authors. A total of 37 people comprised the tasters.

Results—The placements by individuals were variable and ranged from reporting off-flavor for the check (non-treatments) to ordinary potato flavor for the sample from the highest dosage concentration, as is shown in table 1. Some samplers reported that most sample lots were in the ordinary or unimpaired potato flavor category.

TABLE 1.—*Summarization of taste test data, given in percentage.*

Treatment, Lbs. Gamma-isomer Used per Acre*	TASTE CLASSIFICATION								
	Ordinary Potato			Questionable Group Results			Off-Flavor		
	A	B	C	A	B	C	A	B	C
0.88	67	93	72	33	7	7	0	0	21
1.76	56	57	64	33	36	36	11	7	0
3.52	45	50	36	33	29	36	22	21	28
0	89	100	72	11	0	14	0	0	14
3.0	78	64	36	0	36	36	22	0	28
8.3	33	86	43	11	0	21	56	14	36
1.7	44	50	72	44	14	21	12	36	7
0	67	72	93	22	21	0	11	7	7
1.8	44	86	64	56	14	7	0	0	29

*The first four treatments were samples from one experiment, the lower five were from another. The 0.88, 1.76, 3.52 and 8.3 pounds of gamma-isomer were applied with the fertilizer, in bands at the sides of each row. The 3.0, and 1.8 pounds-treatments were broadcast over the soil and disked in, whereas the 1.7 pounds-treatment was a seed piece treatment, and the 0 pounds were check or untreated groups.

Certain tasters, however, tended to report the samples from the check lots as ordinary flavor, and the treatment lots as questionable, or off-flavor, depending somewhat on the amount of benzene hexachloride used. These tasters indicated some real ability to detect the off-flavor produced by the benzene hexachloride.

Since the variations indicated above were obtained, it was deemed desirable to study the mass of data in table 1. In view of the sampling technique and of the method of classification the data were converted to percentages for each sample lot of tubers for each group.

Simple analysis of variance determinations showed that sampling variations might account for the difference between treatments and locations where the classifications "questionable," and "positive off-flavor," were each analyzed separately. Transformation of the data to angles followed by an analysis of variance made no change in the conclusions. After treating the data of all classifications together, by a more complex analysis of variance it was concluded that the classifications "ordinary potato flavor," "questionable," and "positive off-flavor" varied significantly among the treatments, more than could be expected by chance occurrence. Variations among the different locations were unimportant.

A positive relationship was found in which increasingly more tasters reported off-flavor with increases in the amount of benzene hexachloride applied per acre. Trends of this relationship are observed in the data recorded in table 1. These trends are studied by the data from the "Off-Flavor" columns shown in table 1. The average for each treatment was determined and used for a graph, shown in figure 1. It illustrates that the more gamma-isomer used per acre, the more tasters reported off-flavor. The regression line, drawn by mathematical determinations, was found to have a positive significant slope. The formula for the determination of the line is as follows:

$$\text{Expected percentage} = 3.5644\ (\text{pounds gamma-isomer}) + 7.2211.$$

The regression line drawn for the "questionable" classification was nearly flat. The "ordinary flavor" line had considerable slope but in the opposite direction to the line illustrated in figure I.

In the collection of these data, certain weaknesses were observed. The off-flavor leaves a lingering taste, hence dissipation of the flavor before the taster takes another sample lot is an important factor in order to avoid mixing flavors. Some tasters smoked between lots and some washed their mouths with water to clear the lingering taste. There were too many (9) lots to taste within the space of several minutes or the few hours devoted to it. Different tubers in the same lot tasted differently,

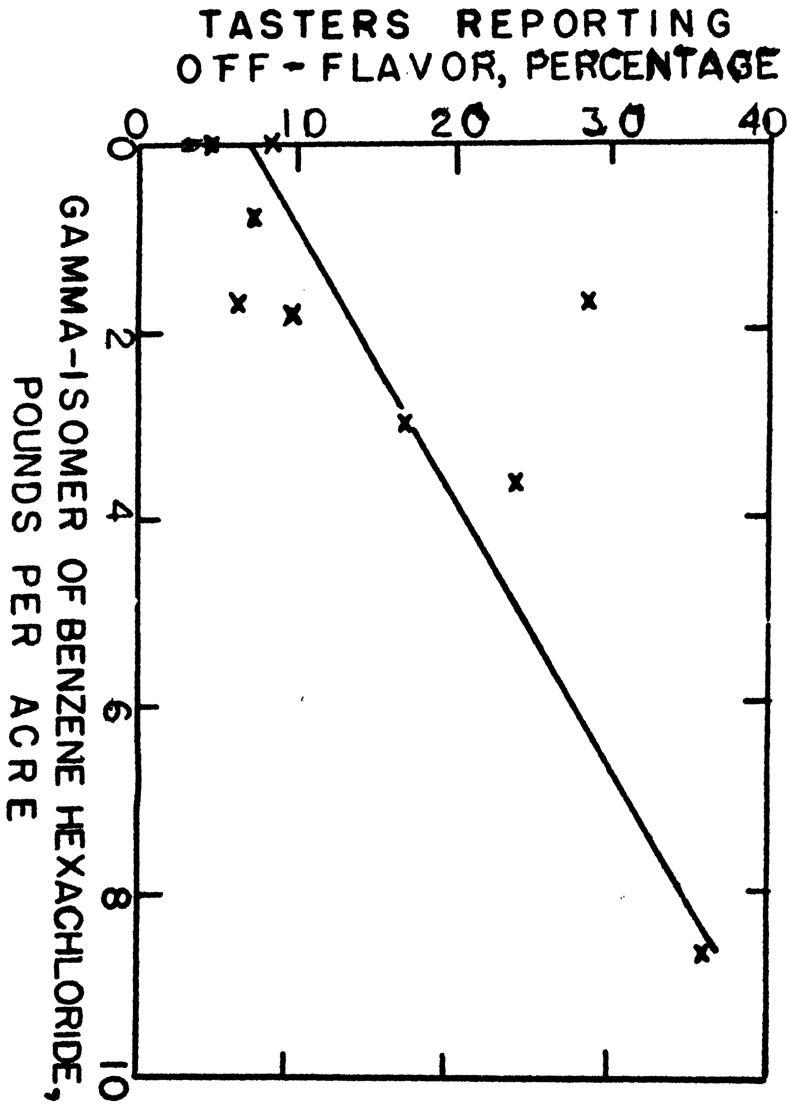

FIGURE 1. Percentage of tasters reporting off-flavor of potatoes from soil treated with different amounts of gamma-isomer of benzone hexachloride.

according to some tasters. The taste was not immediate to some but became apparent later, hence some time should elapse between exposing the sample to the taste buds and recording the results. These variations are apparently to be expected in view of the discussions given by Moncreiff (1946).

Summary:—Samples of potato tubers from experiments conducted for wireworm control were tasted for benzene hexachloride off-flavor. Tubers from soil applications, fertilizer combinations, seed pieces treated with benzene hexachloride, and tubers from check or untreated lots were used in taste tests conducted at three different places. Those who tasted the different samples showed wide variations in their abilities to detect and to determine off-flavor of the tubers. A positive relationship was observed, however, in which samples of potatoes from the higher dosage concentration treatments expressed as pounds of gamma-benzene hexachloride applied per acre were more frequently recorded as off-flavor than those of lower concentrations or of the checks.

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3. Pepper, Bailey B., Clifton A. Wilson and John C. Campbell. 1947. Benzene hexachloride and other compounds for control of wireworm infesting potato. Jour. Econ. Ent. 40: 727-730.
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SECTIONAL NOTES

Maine

The Maine Department of Agriculture has announced that 31,958 acres passed certification this year. The Katahdins showed a big increase, but the Cobblers decreased from approximately 10 thousand to 6 thousand acres. Altogether 15 varieties were certified in 1948.

A State Potato Committee was recently elected to administer the Marketing Agreement. W. L. Berce of Washburn, T. E. Houghton of Caribou, Norman Guy of Fort Kent, Ralph Howard of Houlton, and Keith Smith of Exeter represent the growers. Harold Daigle, Fort Kent; S. A. Wathen, Fort Fairfield; and Millard Otto of Exeter represented the dealers at an open meeting at which every one had an opportunity to express one's self on the matter of grade qualifications. Regulations effective on the 15th of November will allow shipment of 2¼ to 4-inch table stock. Only certified seed will go under previous regulations. The Committee has selected Herbert W. Moore to serve as manager. Moore served as Executive Secretary of the Potato Industry Council and is well qualified to serve the potato committee also.

Maine has harvested a banner crop. The yield per acre of 380 bushels

is the highest on record. An excellent fall season resulted in the crop being dug in fine shape. The snow storm and the cold weather which were experienced about the 16th of October, found more than 90 per cent of the potatoes harvested. Most of the crop harvested after that date was placed in cars and shipped under the Support Program, so any stock which might later have caused trouble has been pretty well disposed of. The crop in storage, therefore, is quality crop. Maine has shipped, as of the 4th of November 6,346 cars, of these the Government has purchased approximately 5,400 cars but these have been loaded so heavily that it is equivalent to approximately 8,200 cars of potatoes.

Some discussions regarding potato allotment and price support have occurred in Maine, but there has been no concerted move to discuss this problem as an industry program.

A survey of Maine growers shows that the Blue Tag Certified Seed Campaign conducted last winter was very successful. A scientific sample of Aroostook growers shows that 85 per cent of the potato acreage was planted with certified seed and another 9 per cent with seed produced in the farmer's own seed plot. This leaves only about 6 per cent of our 1948 acreage being planted with common table stock potatoes. These figures indicate that more than 15 to 20 per cent of Maine's acreage was planted with high quality seed than has ever been used in the past.

New York

Marketing Agreements are receiving a lot of attention. After a joint meeting of the Long Island and New Jersey delegates, a meeting was held in Riverhead this week to explore further the possibilities of starting a Marketing Agreement at once for effective use next fall.

In up-state New York Marketing Agreements have been considered for two years with no definite action. Recently the directors of the New York Cooperative Seed Potato Association which handles more table stock than any other similar organization in the state, went on record as approving the principle of Marketing Agreements and will submit the Marketing Agreement program at our Annual Meeting in December. If the members approve they will assume leadership in sounding out the rest of the up-state growers.

Up-state growers are keenly interested in improving the quality of potatoes going to market and are quite disappointed in having such a large percentage of our crop going into various processing operations. This attitude is a strong factor for promoting Marketing Agreements.

At the Annual Seed School being held at Ithaca from the 22nd-23rd of November the Future of the Certified Potato Industry will be one of

the subjects discussed by growers, distributors and users. Growers of Certified Seed are somewhat discouraged at the narrow margin over table stock prices for seed produced from foundation stock under one of the most rigid inspections and standards in the country. Buyers and users seem reluctant to pay more for quality certified seed than for anything that is eligible to carry a tag. Some interesting angles will be brought out in this discussion.

The crop was one of the largest in the history of the state but is moving to market and to Commodity Credit Corporation outlets in good volume. The surplus will have been moved before freezing weather. — H. J. Evans.

Oregon

To date, 860 acres of Russets have met certification or foundation requirements and 550 acres of White Rose, with a total of 1410 in Klamath County. This is considerably in excess of the acreage approved last year and speaks well for the past two years for the program of seed improvement carried on cooperatively by the Klamath Potato Growers' Association, Klamath County, and the Oregon Extension Service and Experiment Station. As a result, yields are much better and the general quality of pack is greatly improved.

Potato digging was more than 80 per cent completed on the 20th of October. Shipments have been light and the interest in certified seed to date has not been too strongly marked. — C. A. Henderson.

Pennsylvania

In 1948 Pennsylvania harvested not only its highest yield per acre but also crops of the highest quality in its history. Many growers are recording yields well above 750 bushels per acre. Katahdin still remains the standard variety in the state although some of the new blight-immune varieties looked especially fine. Essex yielded high even under dry conditions and although the tubers were not so smooth as Katahdins they presented a good appearance. Kennebec came in second to Essex in both respects; *i.e.*, in yield and appearance. Teton has made a good showing since ring rot seemed more common than ever before.—O. D. Burke.

South Dakota

The best potato crop in a number of years has now been harvested in South Dakota and to date nearly 800 cars and 190 trucks have been shipped. All warehouses are filled and this includes at least 10 new storage houses that were constructed this season. Last year the total shipments from South Dakota were under 1000 cars. The Government has purchased 375 cars with the bulk of these being Number 2 grade

which will be used for alcohol. Some shipments have also been made to Wisconsin for livestock feed.

The Marketing Agreement which prohibits the shipping of potatoes grading less than U. S. Commercial, went into effect on the 15th of September and it was necessary to get a restraining order against one grower who was not eligible for price support and who insisted on marketing field run potatoes after being warned that this violated the Marketing Agreement.

The Government crop report as of the 1st of October estimated the South Dakota potato crop at 2,160,000 bushels harvested from 22,000 acres. It is estimated that 12,000 acres of potatoes were harvested in the Watertown, Clark and Garden City areas with a yield of almost 2,000,000 bushels.

The potato acreage in South Dakota has been decreasing because of the Government programs and the shifting of acreage to larger growers who can afford to maintain modern equipment. Many small growers with an acreage of 4 to 15 have gone out of the business since it is not economical to buy up-to-date machinery for small acreages.

Hollow Heart has been found in Irish Cobblers, Pontiacs and LaSalle potatoes. This will not affect them for seed but it is hard for growers to make the Federal grades because in many cases the damage will exceed 5 per cent.

Of the 7,000 acres entered for certification this year 6,407 passed field inspection. This consisted of 3,907 acres of Bliss Triumphs; 1,499 of Irish Cobblers; 698 of Pontiacs; 175 Red Warbas; and the balance were Early Ohios, White Rose, Russet Burbank, LaSalle and White Warbas. — JOHN NOONAN.

WASHINGTON

There is a plentiful supply of good certified seed potatoes in the state. The tests of these potatoes are now being planted in California and early in January we should know how they are turning out. On the basis of the amount of virus diseases in the field, the tests should be quite satisfactory.

Aside from virus diseases, two fields of potatoes were rejected for the presence of ring rot. One of these was the White Rose variety and another the Netted Gem. Nearly all the Washington potatoes have been harvested. The farmers did not get so high a yield in quite a few fields as last year but still did quite well. Very little has been said so far about reducing acreage or maintaining of support prices, but those who have

expressed an opinion seem to feel that they should like the support price to continue and hope that they will be able to have enough acreage to make potato-growing a profitable enterprise.

The State of Washington is unfortunate in losing the services of Harold Shaad who is leaving to become a farmer. His long service with the State Department and his successful work in certifying seed makes his replacement a difficult task. — M. R. HARRIS.

PROVINCE OF OTTAWA

The potato crop in Canada is practically harvested. In most areas the yields have been exceptionally good and the quality is high.

The damage from late blight has been much lower than was anticipated earlier in the season. Although the total acreage passed in 1948 is higher than in 1947, the total yield for all Canada is estimated at approximately the same as last year, which was 11,474,000 bushels. The average yield of graded stock in 1947 was 219 bushels per acre, whereas in 1948 it was 207 bushels.

The foremost popular varieties continue to be Katahdin, Irish Cobbler, Green Mountain and Sebago — in that order — with, of course, Netted Gem and White Rose being the predominant varieties on the west coast. The production of Chippewa is largely confined to northern Ontario, and Sequoia to Prince Edward Island.—J. W. SCANNELL.

PROGRAM OF THE ANNUAL MEETING OF THE POTATO ASSOCIATION OF AMERICA

December 6, 7, 8, 1948
Hotel Fort Pitt
Pittsburgh, Pennsylvania

President, E. L. NEWDICK, *Department of Agriculture, Augusta, Maine*

Monday Morning, December 6, Hotel Fort Pitt, Assembly Room, 9:30 A. M. Society Session.

JOHN C. CAMPBELL, *Presiding*

1. *Control of Weeds in Potatoes by Pre-emergence Sprays* (15 min.) ORA SMITH, M. W. MEADOWS and E. R. MARSHALL, Cornell University, Ithaca, N. Y.
2. *Revolutionary Changes in Potato Production as a Result of Chemical Weed Control* (15 min.) ORA SMITH, E. R. MARSHALL and M. W. MEADOWS, Cornell University, Ithaca, N. Y.
3. *Effect of Vine Killers and Environmental Factors on Vascular Discoloration in Potatoes* (15 min.) M. W. MEADOWS and ORA SMITH, Cornell University, Ithaca, N. Y.
4. *The Effect of Incorporating* 2, 4-D *in the Regular Spray on the Yield of White Potatoes* (15 min.) N. E. ELLIS, Purdue University, Lafayette, Ind.
5. *Potato Vine Killing in Prince Edward Island* (15 min.) L. C. CALLBECK, Department of Agriculture, Charlottstown, P. E. I., Canada.
6. *Chemical Weed Control Results in* 1948 (15 min.) J. STANLEY COBB, Pennsylvania State College, State College, Pa.
7. *Sprout Inhibition of Non-dormant Chippewa Potatoes* (15 min.) R. H. BRADLEY and LESLIE L. DEAN, Purdue University, Lafayette, Ind.
8. *Effect of Type of Container on the Shrinkage of Stored Potatoes* (10 min. lantern). E. V. HARDENBURG, Cornell University, Ithaca, N. Y.

Monday Afternoon, December 6, Hotel Fort Pitt, Assembly Room 1:30 P. M. Society Session.

ORA SMITH, *Presiding*

1. *Utilization of Potatoes. Production of Useful Fermentation Products* (15 Min.) R. H. TREADWAY and T. C. CORDON, Eastern Regional Research Laboratory, U. S .D. A., Philadelphia, Pa.
2. *Conversion of Potatoes to a Stable Form* (30 min. lantern). R. K. ESKEW, Eastern Regional Research Laboratory, U. S. D. A., Philadelphia, Pa.
3. *Progress in Potato Utilization* (20 min.) R. H. TREADWAY, Eastern Regional Research Laboratory, U. S. D. A., Philadelphia, Pa.
4. *General Discussion — Potato Utilization* (15 min.)
5. *Unusual Variegations in the Sebago Potato*
   1. *Somatic Mutations* (15 min.) W. W. WEBER and G. H. RIEMAN, University of Wisconsin, Madison, Wis.
   2. *Pathological Aspects* (15 min.) R. W. HOUGAS and G. H. RIEMAN, University of Wisconsin, Madison, Wis.

6. *Results of Two Year Tests with Potato Varieties* (15 min.) W. R. MILLS and O. D. BURKE, Pennsylvania State College, State College, Pa.
7. *A New Red Variety of Potatoes Developed in Nebraska* (15 min.) H. O. WERNER, University of Nebraska, Lincoln, Nebr.
8. *Discussion* 15 min.

Tuesday Morning, December 7, Hotel Fort Pitt, Assembly Room 9:00 A. M. Society Session-Business Meeting.

E. L. NEWDICK, *Presiding*

10:30 A. M. *Open Forum—Certification Problems.* Discussion led by R. C. HASTINGS.

Tuesday Afternoon, December 7, Hotel Fort Pitt, Assembly Room 1:30 P. M. Society Session.

HAROLD MATTSON, *Presiding*

1. *Response of Potatoes to Rates and Placement of Nitrogen in Connecticut,* 1948 (15 min.) ARTHUR HAWKINS, University of Connecticut, Storrs, Conn.
2. *The Influence of Irrigation on the Nitrogen, Phosphorus and Potash Requirements of Several Potato Varieties* (30 min., lantern), WALTER C. JACOB, Long Island Vegetable Research Farm, Cornell University, Riverhead, N. Y.
3. *Some Effects of Restricting the Oxygen Supply of Potato Roots* (15 min., lantern), JOHN BUSHNELL, Ohio Agricultural Experiment Station, Wooster, Ohio.
4. *Report on Fertilizer and Cultural Investigations in* 1948 (10 min.) ORA SMITH, Cornell University, Ithaca, N. Y.
5. *General Discussion — Potato Culture* (10 min.).
6. *The Comparative Efficiency of Tuber Indexing and Tuber-unit Planting in the Elimination of Virus Diseases from Seed Potatoes* (15 min.) H. N. RACICOT, Department of Agriculture, Ottawa, Ontario, Canada.
7. *Some Observations on the Bunch-top (Purple-top) Disease in Canada* (20 min. lantern), D. J. MACLEOD, Department of Agriculture, Fredericton, New Brunswick, Canada.
8. *Report on Virus Disease Investigations* (15 min.) R. H. LARSON, University of Wisconsin, Madison, Wis.

Wednesday Morning, December 8, Hotel Fort Pitt, Assembly Room, 9:00 A. M.—Society Session.

W. D. KIMBROUGH, *Presiding*

1. *Experiences with Aerial Application of Insecticides and Fungicides.* (30 min. moving picture), JOSEPH P. MCKENNA, Vahlsing Insecticide and Chemical Corporation, Robbinsville, N. J.
2. *Potato Blight Investigations* (15 min. lantern), W. R. MILLS, Pennsylvania State College, State College, Pa., and L. C. PETERSON, Cornell University, Ithaca, N. Y.
3. *Spraying Potatoes for the Control of Diseases and Insects in Maine* (15 min.) REINER BONDE, Maine Agricultural Experiment Station, Orono, Maine.

4. *The Effects of Zinc-containing Sprays and Dusts on Potatoes* (15 min., lantern) WILLIAM C. HOYMAN, North Dakota Agricultural Experiment Station and State Seed Department, Fargo, N. D.
5. *Results of Insecticidal Applications to Potatoes in North Dakota During* 1948 (15 min.) R. L. POST, WAYNE J. COLBERG and J. ALEX MUNRO, North Dakota Agricultural Experiment Station and State Seed Department, Fargo, N. D.
6. *Results of Spraying and Dusting Potatoes for Late Blight* (15 min.) L. C. CALLBECK, Department of Agriculture, Charlottetown, Prince Edward Island, Canada.
7. *Field Tests of Fungicide-Insecticide Combinations in Michigan for* 1948. (15 min.) J. H. MUNCIE and W. F. MOROFSKY, Michigan State College, East Lansing, Mich.
8. *A Summary of Recent Investigations on Wireworm Control with Organic Insecticides in New Jersey* (15 min.) BAILEY B. PEPPER, J. P. REED, and JOHN C. CAMPBELL, Rutgers University, New Brunswick, N. J.
9. *Results of the National Cooperative Potato Spray Fungicide Experiment in* 1948 (20 min.) W. F. BUCHHOLTZ, Iowa State College, Ames, Iowa.
10. *Insect Investigations in* 1948 (15 min.) A. A. GRANOVSKY, University of Minnesota, St. Paul, Minn.

Wednesday Afternoon, December 8, Hotel William Penn, Monongahela Room, Joint Session with The American Phytopathological Society.

W. R. MILLS, *Presiding*

1. *Transmission of Purple-Top of Potatoes.* (15 min., lantern) R. L. SELF and H. M. DARLING, University of Wisconsin, Madison, Wis.
2. *Reaction of Potato Varieties to the Virulent Ringspot Virus.* (15 min., lantern) R. C. LADEBURG and R. H. LARSON, University of Wisconsin, Madison, Wis.
3. *Isolation of Virulent Ringspot Virus from "Healthy" Potatoes.* (15 min., lantern) R. H. LARSON and R. C. LADEBURG, University of Wisconsin, Madison, Wis.
4. *The Effect of Various Diluents on the Infectivity of the Potato X Virus.* (15 min., lantern) R. E. WILKINSON and A. FRANK ROSS, Cornell University, Ithaca, N. Y.
5. *Potato Virus Disease Research in Mexico.* (15 min.) JOHN S. NIEDERHAUSER Rockefeller Foundation, Mexico D. F., Mexico.
6. *Effect of the Leaf Roll and X Viruses on Stand and Yield of Potatoes.* (10 min., lantern) R. E. WILKINSON and F. M. BLODGETT, Cornell University, Ithaca, N. Y.
7. *Some Specific Characters of Erwinia atrospetica* (van Hall) Jennison *and Erwinia carotovora* (Jones) Holland. (15 min.) WILSON L. SMITH, JR., Cornell University, Ithaca, N. Y.
8. *Location of Bacteria in Healthy Potato Tissue.* (10 min., lantern) J. P. HOLLIS, University of Nebraska, Lincoln, Nebr.
9. *Factors Affecting Lesion Formation on Physalis floridana.* (15 min. lantern) A. FRANK ROSS, Cornell University, Ithaca, N. Y.
10. *Reaction of Hybrid Potato Varieties to Infection by Fusarium eumartii.* J. H. MUNCIE, Agricultural Experiment Station, East Lansing, Mich.
11. *Aphid Transmission of Potato Virus Diseases in Storage.* (10 min., lantern) A. A. GRANOVSKY, University of Minnesota, St. Paul, Minn.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912.

Of American Potato Journal, published monthly at New Brunswick, New Jersey, for November 18, 1948.

State of New Jersey
County of Middlesex ss

Before me, a Notary Public in and for the state and county aforesaid, personally appeared H. H. Martin, who having been duly sworn according to the law, deposes and says that he is the Editor of the American Potato Journal and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411. Postal Laws and Regulations, printed on the reverse of this form, to-wit:

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W. H. MARTIN, Editor.

Sworn to and subscribed before me this 18th day of November, 1948.
R. E. Long, Notary Public, Middlesex County, New Jersey.
(My Commission Expires January 31, 1949).
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THE REACTION OF PAWNEE AND BLISS TRIUMPH POTATOES TO CERTAIN PHYSIOLOGIC RACES OF *ACTINOMYCES SCABIES*

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INTRODUCTION

The reaction of potato varieties to common scab caused by *Actinomyces scabies* (Thaxt.) Güssow, is quite variable. Leach *et al* (1) showed that physiologic races of *A. scabies* are responsible for this variation in severity of scab. Subsequent investigations (2) showed that a large number of physiologic races are present in soils and certain varieties of potatoes are susceptible to a large number of races.

The varieties Pawnee and Bliss Triumph have been found to be susceptible to many races of *Actinomyces scabies* in Colorado. Occasionally Pawnee has been free from scab when grown in soil producing severely scabbed Bliss Triumph. This variation in the resistance of a given seedling or named variety has been noted in certain local areas, and suggests that Pawnee is resistant to certain races common in Colorado soils that cause severe damage to Bliss Triumph.

The production of variants in physiologic races of *Actinomyces scabies* occurs quite commonly in culture media (2) and there is little doubt that variants are also produced by the organism while growing as a saprophyte in the soil and also as a parasite on the potato tuber. Several

culturally different races of *A. scabies* have been isolated from a single pustule. Either a mixture of races was responsible or mutants occurred in the pustule. Increase in the pathogenicity of these variants has not been demonstrated, but is considered to be quite possible.

It has been demonstrated that certain varieties of potatoes differ in their reaction to the various races of the scab organism present in the soils of Colorado. Bliss Triumph, Pawnee, Irish Cobbler, Katahdin, and Rural New Yorker all became scabby in certain soils. In other soils all but Pawnee were free from scab. In a few cases, Irish Cobbler and Bliss Triumph were found to be completely susceptible and Pawnee free from infection. A difference in pustule type on Pawnee suggests a race of *Actinomyces scabies* that is more or less specific for this variety.

Experimental Data

The variety Pawnee has consistently shown a No. 3, or intermediate, type of scab pustule when grown in the Greeley district of northern Colorado where this variety was developed. In some areas of Colorado and infrequently in the Greeley area a crop of practically scab-free tubers has been grown. Frequently Bliss Triumph grown on the same soil showed a No. 4 or No. 5 type of scab pustule.

Experiment No. 1

The scab organism was isolated from a No. 3 type of pustule common on Pawnee and from a No. 4 type of pustule on Bliss Triumph grown in the same soil. The isolates from these two varieties differed culturally. Culture No. 386, isolated from a No. 3 type of pustule on Pawnee, was grayish white with abundant mycelial growth, and was non-pigment-forming on modified potato dextrose agar. (a) Culture No. 346, isolated from a No. 4 type pustule on Bliss Triumph, was dark gray with abundant aerial mycelium and produced a dark-brown pigment on modified potato dextrose agar. Culture No. 346 had the strong, earthy odor characteristic of some races of *Actinomyces scabies*, whereas culture No. 386 produced a very mild Actinomyces odor or none.

Result of Inoculating Pawnee and Bliss Triumph Tubers with Cultures Nos. 386 and 346

Scab-free seed pieces of both varieties, Pawnee and Bliss Triumph, were surface disinfected in 1-1000 mercuric chloride for 1 hour, washed for 1 hour under running tap water, and planted in sterilized soil in the greenhouse. For each variety four pots were inoculated with culture No. 386 and four with No. 346, at planting time and again when the tubers were forming; two check pots received no inoculum. The inoculum was

TABLE 1—*Cultural characters and parasitic action of Actinomyces scabies isolated from Pawnee and Bliss Triumph tubers in Colorado.*

Experiment	Culture Number	Source of Culture	Color of Mycelium	Pigment Produced in Modified P.D.A.	Actinomyces Odor	Type of Pustule on Pawnee	Type of Pustule on Bliss Triumph
I	386	No. 3 Type of Pustule on Pawnee	Grayish White	None	Weak	No. 3	None
	346	No. 4 Type of Pustule on Bliss Triumph	Steel Gray	Brown	Strong	None	No. 4
II	320	No. 5 Type of Pustule on Pawnee	Grayish White	None	Weak	No. 5	No. 5
	347	No. 5 Type of Pustule on Bliss Triumph	Grayish White	None	Weak	No. 1	No. 5

prepared by scraping the scab organism from colonies grown on modified potato dextrose agar in petri dishes and mixing with sterile water. It was added directly to the soil in the pots. When the plants were mature the tubers were examined for scab pustules.

The first part of table 1 summarizes the effect of these two isolates on Pawnee and Bliss Triumph tubers. Culture No. 386 from a No. 3 type of pustule on Pawnee, produced a No. 3 type of pustule on Pawnee tubers, but no infection on Bliss Triumph. Culture No. 346 from a No. 4 type of pustule on Bliss Triumph produced a No. 4 type of pustule on Bliss Triumph tubers, but no infection on Pawnee tubers. Each of these cultures attacked the variety from which it was isolated, but not the other variety tested.

Inoculation Experiment No. 2

Occasionally a deep No. 5 type of scab pustule is found on Pawnee tubers grown in commercial fields of northern Colorado. Often two types, the shallower No. 3 and the deep No. 5, are found on the same tuber. The No. 5 type often infects the tuber to a depth of 8-10 mm., similarly to the No. 5 type commonly found on Bliss Triumph.

The scab organism was isolated from a No. 5 type of pustule on Pawnee and from a No. 5 type on Bliss Triumph grown in the same soil. Inoculation of sterlized soil was done as previously described in Experiment No. 1. Results of these inoculations are summarized in table 1.

Culture No. 320, isolated from a No. 5 type of pustule on Pawnee, produced a No. 5 type on both Pawnee and Bliss Triumph tubers in this greenhouse test. Culture No. 347, isolated from a No. 5 type of pustule on Bliss Triumph, produced a No. 5 type on Bliss Triumph but a No. 1 type on Pawnee (Fig. 1). These results indicate that a race of *Actinomyces scabies* causing a No. 5 pustule on Pawnee may cause a similar pustule on Bliss Triumph, but that a race causing the deep pustule on Bliss Triumph may not cause a similar deep pustule on Pawnee. Thus Bliss Triumph appears to differ from Pawnee in susceptibility to certain races of *A. scabies*. Differences in odor production and mycelium color in the four isolates studied could not be correlated with parasitism as shown in table 1.

Summary

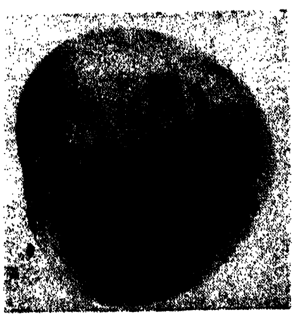
Bliss Triumph and Pawnee potatoes are commonly infected with scab in Colorado soils; but occasionally Pawnee is found to be free from scab in soils that produce a scabby crop of Bliss Triumph. This suggests that Pawnee is resistant to certain races of *Actinomyces scabies* that may scab Bliss Triumph severely.

(a) Formula for culture medium: Pared potatoes, 300 gm.; dextrose, 5 gm.; agar, 20 gm.; tap water, 1000 cc.

Experiments with four isolates of *Actinomyces scabies* in the greenhouse showed that Pawnee was resistant to two races that caused deep scab on Bliss Triumph; also that a race causing an intermediate type of pustule on Pawnee did not produce scab on Bliss Triumph.

No. 5 Type of Pustule on
Bliss Triumph
Culture No. 320

No. 5 Type of Pustule on
Bliss Triumph
Culture No. 347



No. 5 Type of Pustule
on Pawnee
Culture No. 320

No. 1 Type of Pustule
on Pawnee
Culture No. 347

FIG. 1. Types of pustules produced on Pawnee and Bliss Triumph tubers when grown in soil inoculated with two races of *Actinomyces scabies*.
Culture No. 347 from a No. 5 type of pustule on Bliss Triumph.
Culture No. 320 from a No. 5 type of pustule on Pawnee.

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A COMPARISON OF *CORYNEBACTERIUM SEPEDONICUM* INOCULA FROM RESISTANT AND SUSCEPTIBLE POTATO VARIETIES

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Since it was found that ring-rot-resistant potato seedlings commonly carry the causal bacteria, *Corynebacterium sepedonicum*, without showing the usual plant symptoms, there has been some doubt regarding the advisability of distributing such potato varieties to commercial areas. In addition, some workers have found that bacteria were more abundant in resistant varieties than in susceptible ones and have suspected that they might be even more pathogenic.

With this thought in mind, the authors conducted experiments during 1946 and 1947 to determine primarily the relative pathogenicity of ring-rot bacteria carried by resistant and by susceptible potato varieties.

In 1946 the tests were preliminary in scope but they were continued in 1947 on a more extensive basis.

EXPERIMENTAL METHODS

In 1946 one lot of twenty Teton tubers was inoculated with infected Teton tubers by rubbing the cut surfaces of each together until the bacterial ooze was well distributed. Another lot of Teton tubers was inoculated similarly with infected Bliss Triumph tubers and all seed pieces were planted soon after inoculation at the Agronomy Farm, Laramie. In another test, Bliss Triumph tubers were inoculated with ooze from resistant tubers, whereas an additional lot was inoculated with ooze from susceptible tubers. In a like manner, Teton tubers were inoculated with the two types of inocula. Forty seed pieces were inoculated in each lot by rubbing the cut surfaces of the seed pieces with the cut surfaces of infected tubers and later dipping them in a thick suspension of the bacteria just prior to planting.

In 1947 experiments were conducted both at Laramie and Torrington Stations, using bacterial ooze from Bliss Triumph, Red McClure and Teton potato varieties to inoculate these three varieties and, in addition, the Burbank, in all combinations. The tests were made in units of ten tubers each with two replications. These tubers were cut into two seed pieces after which they were inoculated with ring-rot bacteria from the different sources, by rubbing together the cut surfaces of healthy and in-

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fected tubers. One-half of each inoculated tuber was planted at Laramie, while the other half was planted two days later at the Torrington Station located 140 miles away and 3,000 feet lower in elevation. Another experiment was conducted at Laramie in which resistant varieties and seedlings and susceptible varieties were inoculated in a similar manner with ring-rot ooze taken from susceptible varieties and also from resistant varieties. All were planted in ten-hill units replicated four times.

The seed pieces in all tests gave good germination and stands. Disease readings were made at approximately weekly intervals after ring-rot symptoms began to appear, until September the 11th, at which time the last disease inspection was made.

During the latter part of September, one stem was collected from each hill in the unit, consisting of 20 hills. These stems were put in newpaper bags, labeled and brought into the laboratory where they were thoroughly washed and dried of excess moisture. The lower portions of the stems were cut off and the freshly-cut sections were pressed firmly against the glass slide. These smears were later stained and examined microscopically for the presence of bacteria . The scalpels were sterilized thoroughly between each stem cut by first dipping them in mercuric chloride (1 :500) for a period of 15 seconds or more, after which they were wiped dry with sterile cotton and heated thoroughly in a Bunsen flame.

The tubers were then harvested from each unit, placed in storage and will be examined again at the end of the storage period.

Experimental Results

In 1946 the results showed that when tubers of the Teton variety were inoculated with ooze taken from tubers of the Bliss Triumph variety, 17 per cent ring rot was found. Similarly, when Teton tubers were inoculated with ooze from infected Teton tubers, 20 per cent ring rot resulted. In another test, when Bliss Triumph tubers were inoculated with ooze from resistant seedlings, 91 per cent of the plants showed ring rot, whereas inoculum from susceptible seedlings yielded 97 per cent ring rot. Moreover, resistant seedlings inoculated with ooze from resistant tubers gave 21 per cent, whereas the inoculum from susceptible seedlings gave 15 per cent ring rot.

In 1947 when susceptible and resistant varieties were inoculated with ooze from both susceptible and resistant varieties, the results were, for the most part, in favor of the susceptible inoculum, both in percentage of plants infected and the severity of plant infection, as will be noted in table 1.

TABLE 1—*The prevalence and severity of ring rot (plant symptoms) on September 7 in three potato varieties inoculated with ooze from susceptible and resistant varieties and planted June 5, 1947.*

Ring-rot Inoculum Used	Varieties* Inoculated and Resulting Ring Rot					
	Red McClure		Burbank		Bliss Triumph	
	Per Cent	Index**	Per Cent	Index**	Per Cent	Index**
Ooze from susceptible varieties	54	1.0	93	2.8	100	3.4
Ooze from resistant varieties and seedlings	40	0.6	65	1.4	100	3.0

*The Teton variety and several resistant seedlings were inoculated but the plant symptoms were so slight that they were not included in this table.

**Index figure calculated showing average severity of plant infection, — 1 = slight, 5 = entirely killed.

Ring-rot infection was equally or more prevalent in all varieties tested when inoculated with inoculum from Bliss Triumph tubers as compared with inoculum from the Teton and Red McClure varieties. The same was true for ring-rot severity as shown by the index figure. Ring-rot symptoms developed much earlier in the susceptible Bliss Triumph than they did in the partially-resistant Burbank and Red McClure. The plant symptoms of ring rot were so slight in the Teton variety that they were not included along with the other varieties shown in table 2.

The results obtained at Torrington in the comparison of inocula on the Bliss Triumph variety were similar to those obtained at Laramie. These data are recorded in table 3.

Although the Torrington plot was planted two days later than those at Laramie, ring-rot symptoms were visible a few days sooner at Torrington than at Laramie, due to differences in climatic conditions. However, the symptoms of ring rot were more visible and clear-cut at Laramie than at Torrington, partly because the plants at Laramie remained erect, whereas those at Torrington grew tall and lodged. Later they grew up again, for the most part, between the rows. Moreover, the factors were more favorable for the development of early blight at Torrington than at Laramie.

Microscopic examination of the slides showed that, as an average of all inoculations, far more bacteria were present in the Red McClure, Bliss Triumph and Burbank varieties than in the Teton variety. Furthermore,

TABLE 2—*The prevalence and severity of ring rot (plant symptoms) in the Red McClure, Burbank and Bliss Triumph varieties when inoculated with infected tubers of Bliss Triumph, Red McClure and Teton varieties and planted at the Agronomy Farm, Laramie, Wyoming, June 7, 1947.*

Varieties Used As Sources of Inocula	Date of Inspection	Varieties Inoculated and Resulting Ring Rot: Red McClure Per Cent	Red McClure Index*	Burbank Per Cent	Burbank Index*	Bliss Triumph Per Cent	Bliss Triumph Index*
Bliss Triumph	Aug. 18	0	0	0	0	100	1.5
Red McClure	" "	0	0	0	0	70	1.6
Teton**	" "	0	0	0	0	60	0.9
Bliss Triumph	Aug. 30	0	0	0	0	100	3.0
Red McClure	" "	0	0	0	0	85	3.0
Teton	" "	0	0	0	0	95	2.7
Bliss Triumph	Sept. 3	0	0	0	0	100	3.7
Red McClure	" "	0	0	0	0	95	3.3
Teton	" "	0	0	0	0	100	3.3
Bliss Triumph	Sept. 7	10	0.5	55	1.2	100	3.8
Red McClure	" "	0	0	38	0.8	95	3.4
Teton	" "	5	0.1	40	0.7	100	3.4

*Index figure calculated showing average severity of plant infection,—1 = slight, 5 = entirely killed.

**This variety was also inoculated but the ring-rot symptoms were so slight that it was not included in this table.

TABLE 3—*The prevalence and severity of ring rot (plant symptoms) in the Bliss Triumph potato variety when inoculated with infected tubers of the Bliss Triumph, Red McClure and Teton varieties and planted at Torrington, Wyoming, on June 9, 1947.*

Varieties Used As Sources of Inocula	Resulting Ring Rot (plant symptoms) in the Bliss Triumph Variety* at the Dates Inspected: Aug. 11 Per Cent	Aug. 11 Index**	Aug. 29 Per Cent	Aug. 29 Index**	Sept. 5 Per Cent	Sept. 5 Index**	Sept. 11 Per Cent	Sept. 11 Index**
Bliss Triumph	15	.12	100	1.9	100	2.3	100	2.5
Red McClure	5	.05	55	0.6	60	0.8	60	0.8
Teton	25	.22	85	1.3	90	1.5	90	1.8

*The Red McClure, Burbank and Teton varieties were also included but the results are not used here as the symptoms were indefinite, because of the prevalence of early blight.

**Index figure calculated showing average severity of plant infection,—1 = slight, 5 = entirely killed.

TABLE 4—*The relative prevalence of bacteria found in stem smears made from inoculated plants in each varietal test at the Agronomy Farm, Laramie, 1947.*

Varieties Used As Sources of Inocula	Relative Prevalence of Bacteria* from Stems of Four Potato Varieties				
	Teton	Red McClure	Burbank	Bliss Triumph	Average
Bliss Triumph	1.5	6.6	4.4	7.3	5.0
Red McClure	1.3	4.8	4.1	4.2	3.6
Teton	0.7	5.7	5.8	4.7	4.2
Average	1.2	5.7	4.8	5.4	

*Rating scale—1 = few bacteria, 10 = maximum number found.

as sources of inocula, the Bliss Triumph infected tubers produced, on the average, more bacteria in the stems of all inoculated varieties than either the Red McClure or Teton.

SUMMARY AND CONCLUSIONS

Experiments were conducted in 1946 and 1947 to determine whether or not ring-rot bacteria, *Corynebacterium sepedonicum*, from resistant potato seedlings and varieties were more pathogenic than those from susceptible varieties.

Bliss Triumph, Burbank, Red McClure and Teton tubers were inoculated, in all combinations, with inocula from ring-rot-infected tubers of the Bliss Triumph, Red McClure and Teton varieties. Resistant seedlings and susceptible varieties were also each used collectively as sources of inocula.

Under the conditions of the experiment, the percentage of ring-rot infection and the severity of infection caused by inocula from susceptible varieties was equal to, if not greater than, that caused by inocula from resistant varieties.

Plant symptoms developed much earlier in the Bliss Triumph variety than in the Burbank, Red McClure and Teton varieties. Symptoms of ring-rot were slight to absent in the latter variety.

In this experiment, the conditions at the Laramie Station (7165 feet elevation) were better adapted for ring-rot symptoms in the plants than at the Torrington Station (4104 feet elevation), although the plant symptoms took a few days longer to become visible at the higher altitude than at the lower one.

Microscopic examination of the slides showed that, as an average of all inoculations, far more bacteria were present in the Red McClure, Bliss Triumph and Burbank varieties than were present in the Teton variety. Furthermore, as sources of inocula, the Bliss Triumph tubers produced, on the average, relatively more bacteria in the stems of other varieties tested than either the Red McClure or Teton variety.

The results of these experiments show that ring rot bacteria infecting the Teton variety and ring rot-resistant seedlings were not more pathogenic than those carried by susceptible varieties, such as the Bliss Triumph.

RESEARCH ON HARVESTING, TRANSPORTATION AND STORAGE OF POTATOES — A REVIEW OF RECENT LITERATURE

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Introduction

As this review is necessarily very brief no attempt has been made to make it complete but it is believed that most of the significant work is included. For the most part this review dates from January, 1945, to the present, although occasionally an older publication is listed to provide continuity.

Early Potatoes

Handling and Transportation

Rose (36) has brought together most of the published and unpublished data on this subject. He points out that early potatoes are highly perishable and should be handled accordingly. Potatoes should be picked up within 15 to 30 minutes after being dug, especially on hot, dry, or windy days. Even after being picked up they should be brought from the field as soon as possible. An additional factor of great importance is to protect newly-harvested potatoes from the wind.

In general, a pyramid load in the refrigerator car is most desirable. Transit temperatures below 70°F are highly preferred. During warm weather some sort of refrigeration is highly beneficial. For short hauls pre-icing is the preferred method of shipment, and for long hauls

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one re-icing in addition is desirable. Pre-cooling alone has not been generally satisfactory commercially because the length of the pre-cooling period is too short to cool the load adequately. Fan-cars are superior to standard cars in refrigerated shipments.

Bacterial soft rot particularly during transit and on the markets has been a serious problem and has been given attention by a number of workers. Bennett (5) reports a soft rot epidemic in Great Britain which was associated with immature potatoes under conditions of lack of air, high temperature, moist atmosphere and pressure. Smith and Ramsey (38) reported that decay following lenticel invasion by bacteria was usually more serious in potatoes grown in wet or heavy soils. Eddins (14) also found that soft rot was very severe in fields where the soil remained water-logged for several days. Nielson (29) discovered that tubers when exposed for a period of a certain duration, reached a temperature of 113°F or higher (sub-lethal), and even though they exhibited no symptoms of injury, were more susceptible to bacterial soft rot than are potatoes not so exposed. This change appears to be reversible.

The elimination of conditions which predispose the early crop potatoes to decay and proper transit temperatures seem to be the most effective means of controlling losses from bacterial soft rot during marketing (36). Eddins (13) believes that driers should also reduce losses from soft rot.

Aside from decay, browning of skinned areas is an important source of loss (36). Benn (4) found that air movement during the period when the evaporative capacity of the atmosphere is high was the most important cause of browning. If this injury is severe, decay organisms may enter. Sunlight in itself had no effect on browning. Unskinned potatoes were seldom injured.

Storage

Although early potatoes are not generally stored in great quantities there are occasions when such storage is practiced, and unless properly done, considerable loss may occur. Kimbrough (24) found that curing for 1 to 2 weeks before storage at 35 to 40°F is recommended. A storage temperature of 40° was found to be superior to 35°. Katahdins kept much better at this temperature than did Triumphs. Lutz (27) reported that the storage of Triumphs under non-refrigerated conditions, such as a shed or basement resulted in very high losses. For a storage period of less than 3 months, storage at 50° was best although 40 to 60° was also quite satisfactory after the potatoes had been cured 4 days or longer at 60° prior to storage at 40°. For five months

storage-cured potatoes stored at 40° kept best, although immediate storage at 50° gave fair results.

Late Crop Potatoes

Vine Killers

Hoyman (20) found that in the absence of dew, dusts are not effective and Otis (30) does not recommend dusts in eastern Oregon because of low humidity.

Hoyman (20) discovered that the American Cyanamid Company Weed Killer A (37½-50 lbs. per 100 gals.) destroyed the weeds most rapidly. Dowspray 66 (2 gals. per 100 gals.) was more effective when 2 pounds NH_4SO_4 was added. The discoloration found in and near the vascular tissue of the tubers may or may not be a direct effect of the chemical, as mechanical cutting of the vines also produces this effect. The amount of discoloration was correlated with the rapidity of kill and was less when applications were made later in the season.

In Colorado, Kunkel (25) reported that all mechanical methods such as top pulling or cutting or undercutting of roots have disadvantages under some conditions and with some varieties. Dowspray 66 (2 gals. per 100 gals.) and Sinox (2 gals. per 100 gals. plus 10 pounds NH_4SO_4) when applied at the rate of 100 gallons per acre killed the tops in approximately 3 days and showed most promise. Both materials induced browning or discoloration at the stem end, but the general effect is not so clear for sometimes more discoloration occurs when vine killers are not used. Flaming is another possibility.

Harvesting

Bierly and Hardenberg (7) report that an inexperienced picker made about twice as many moves and picked up less than one-half as many potatoes as an experienced one.

Rest Period and Sprouting

Sprout Accelerators

No recent reports on materials newer than ethylene chlorhydrin or ammonium thiocyanate for breaking the rest period of potatoes have appeared.

A large scale test was conducted by Porter and Simpson (33). Ethylene chlorhydrin was used on more than 3000 bushels of Maine-grown potatoes in order to obtain early emergence in Florida for virus readings on the plants. By special variations in treatment for each variety they were able to get 95 per cent of the plants large enough for virus readings by the end of January.

A comparison of the ethylene chlorhydrin treatment with ammonium thiocyanate was made by Townsend (42). The yields after the latter treatment, were equal to or greater, than, the former. With

ammonium thiocyanate he could treat either freshly-cut or suberized seed pieces. They were dipped in a 0.75 to 1.0 per cent solution and allowed to stand 18 to 20 hours before planting. This treatment was considered easier and safer.

Pujals *et al* (34) have conducted experiments on the treatment of seed potatoes, first, with sprout inhibitors, and then with sprout accelerators. Two varieties were treated with the methyl ester of naphthalene acetic acid and ethyl naphthyl acetate. Previous to planting time they were treated with ethylene chlorhydrin to induce sprouting. Seed tubers thus treated did not yield so well as the checks, but the authors feel that with proper timing the yield should be equal to that of untreated tubers.

Sprout Inhibitors

In the field of sprout inhibitors the use of methyl ester of naphthalene acetic acid has proved the most satisfactory. In work reported by Daines and Campbell (12) the use of ⅔ to 1⅓ grams per bushel on Irish Cobbler or Katahdin varieties of potatoes proved more effective as a dust than when used on paper strips. Alban (2) working with (1) naphthalene-acetic acid, (2) indol butyric acid, and (3) naphthoxy-acetic acid and (4) 2,4-dichlorophenoxyacetic acid, with their salts and methyl esters, it was found that, in general, the methyl esters particularly of napthalene acetic acid were most efficient. Dust treatments were more effective than other methods used. In a study in consumer-packaging to reduce sprouting and also weight loss a combination of methyl ester of naphthalene acetic acid and Brytene 489A wax proved very effective. Smith (39) recommends a dust application as most effective in small lots used at the rate of .9 to 1.0 gms. methyl ester of naphthalene acetic acid per bushel. With amounts of more than 1000 bushels he recommends the use of a paint spray gun or aersol. For the spray gun he suggests a mixture of 1:1 with methyl alcohol, and with aersol he suggests using methyl chloride 1:9. In either case the application should be regulated so as to apply 1 gram of hormone per bushel. Kardos and Blood (23) found that maintaining an atmosphere of 10.5 per cent CO_2 and 13.6 per cent O_2 was fully as efficient as the methyl ester of naphthalene acetic acid. The retardation effect persisted to a considerable degree after removal to normal atmosphere. No "off" flavors were noted after cooking.

Chemical Composition and Cooking Quality

Ascorbic Acid Content

All workers report serious losses in ascorbic acid content during storage. Werner and Leverton (44) found that the ascorbic acid content varied with varieties, seasons, and within the same varieties. When the

vines were at the maximum vigor of growth the tubers averaged 35 to 55 mgs. per 100 gms. but when harvested a month later they had 30 to 40 mgs. per 100 gms. A higher amount of vitamin C was found in dry land culture than under irrigation. Less loss occurred from 50° to 70°F storage than at 40° to 50°. During cooking there was less loss in a minimum of water than when a large amount of water was used. Murphy (28) also found more vitamin C loss at low temperatures. Less loss occurred at 60° to 70°F than at 32° to 36°. Fifty degree storage seemed best because of less general deterioration. There was an over-all average loss during storage from 22.7 to 6.3 mgs. per 100 gms. with ⅓ to ½ of this loss occurring the first month. Work of Roberts and Cameron (35) showed that during 6 to 7 months storage the loss of ascorbic acid amounted to 60 to 70 per cent. They also reported that the ascorbic acid content in individual varieties from different sections of the country was reasonably consistent.

Cooking Quality

Clark *et al* (10) pointed out the correlation between specific gravity of the raw product and the mealiness of the cooked product. As a result, in recent studies pertaining to the cooking quality of potatoes, considerable attention has been given to specific gravity.

LeClerg (26) ascertained that soil and climatic conditions did not influence the relationship between specific graviety and dry-matter content. Neither dry-matter nor specific gravity were significantly correlated with the weight of tubers.

In a study of the inheritance of dry-matter content it was discovered by Akeley and Stevenson (1) that the high density character seemed to be dominant over low density.

Caldwell *et al* (9) in their studies discovered that potato samples with high specific gravity gave a larger yield of the dehydrated product. These proved mealier and gave a generally better over-all quality than that from low specific gravity.

Briant (8) *et al* in a study of the physical properties of starch from potatoes showed a negative correlation between the number of starch granules below 0.02 mm. and the degree of mealiness. It was also shown that 16 per cent starch suspensions from the mealy potatoes jelled at a lower temperature and were less rigid than similar suspensions from the less mealy samples.

Discoloration in Cooking

Little or no definite information has appeared on the cause of discoloration of cooked potato products, except that greying or blackening is more prevalent in certain varieties and browning is correlated with

high reducing sugar. Bandemer *et al* (3) pointed out that discoloration increased with increase in moisture content and decrease in pH of the tuber. They further suggest that with the hydrolysis of sugar there is a combination with proteins to produce browning. Patton and Pyke (31) reported that the presence of reducing sugar in combination with amino acid was responsible for the browning of potato chips. Pollard (32), working in Great Britain, reported that blackening is not influenced by the pH of the soil. Site was an important factor and on good sites potash improved color. Wager (43) reported that stem-end blackening or greying was due to a single pigment—not melanin—whose color is influenced by pH.

"Off" Flavor

Benzene hexachloride shows promise of controlling wireworm but has a musty odor which flavors such food as potatoes (22).

Diseases

Physiological

Folsom (17) reports that internal mahogany browning which has been previously shown to be caused by continuous storage for several months at 32°F varies with variety. Predisposition to this disorder is inherited and the author, suggests that for Northern potato growing regions the proper selection of parents for crosses can be helpful in developing varieties resistant to this defect.

Ross (37), in his work, found that stem-end browning which develops in storage varies in different strains of Green Mountains with the susceptible strain producing 2 to 7 times as much stem-end browning as the more resistant strains. Selections from susceptible strains were of no value. All Irish Cobbler lots were highly susceptible.

Wiant (45) investigating internal black spot of Long Island potatoes found that much of the disorder resulted from mechanical injuries sustained by pressure bruises during grading and sacking.

Investigations pertaining to the greening of potatoes (18) showed that potatoes greened faster at room temperatures than in a cool place. They also faded faster (in the dark) when warm than when cool. When exposed to the natural light in a cool greenhouse for two days it required a month or more in a warm dark storage to degreen them. When exposed to the light for a longer period, a period of several months was required. Cortical greening developed faster and faded less in Katahdins than in Chippewas and Green Mountains. When the greening is severe the green portion is replaced by red or brown when degreened.

Pathogenic

Bonde and Schultz (6) in their studies found that much of the late blight tuber rot in Maine resulted from harvesting while the fungus was still viable and before the plants were dead.

Thomas and Lane (41) in Colorado observed a condition where despite the fact that field losses from late blight were not heavy, the abnormal precipitation and late irrigation in September washed the inoculum to the tubers resulting in a 2 per cent storage loss. These conditions also caused more than 5 per cent storage loss because of "Western leak" caused by *Pythium* spp. and *Phytophthora* spp.

Cunningham and Reinking (11), investigating fusarium seed piece decay of potatoes on Long Island, found that the fusaria causing this decay gain entrance only through wounds. They will not enter through properly healed seed pieces.

Starr (40) has developed minimum requirements for the steam sterilization of burlap bags to kill potato ring-rot bacteria.

The description and method of control of potato diseases are discussed by Jensen and Levingston (21).

Storage Structures

At least five million bushels of late crop potatoes are stored in "shell cooled" storages which are adapted for use in the warmer section of the late-crop area. The principle of this method is to provide for circulation spaces in the walls and floor to allow cool air to pass around instead of through the bins. The high humidity thus maintained in the bins helps to reduce shrinkage and the low humidity elsewhere can be expected to prolong the life of the building (15).

Edgar (16) presents information and plans for storing potatoes in the parts of the U. S. where climatic conditions will permit good storage without refrigeration. For short storage periods—3 or 4 months or less—a minimum temperature of 50° is suggested. For longer storage a minimum of 40° but warming to 50°, two weeks before marketing, is recommended. Information regarding the construction and operation of these storage structures is also included.

Weight Losses in Storage

Alban (2) found that after 1, 4, 8 and 12 weeks storage at room temperatures, weight losses amounted to 1.2, 3.2, 6.4 and 11.6 per cent, respectively. Slightly less losses occurred in paper bags. Losses at room temperatures varied from 2 to 3 times as much as at cold storage.

Miscellaneous

Hannay and Hareide (19) have presented a bibliography on recent literature (1942-1946) pertaining to the marketing of fruits and vegetables.

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TESTS OF CUTTING KNIFE DISINFECTANTS AND CUTTING TECHNIQUES IN THE CONTROL OF RING ROT OF POTATOES[1]

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INTRODUCTION

Ring rot, caused by *Corynebacterium sepedonicum* (Spieck. & Kott.) Skapt. & Burk., continues to be an important potential source of loss to growers of commercial potatoes, especially those who use non certified seed. Such seed lots may contain from a trace to 5 or more per cent of ring-rot infected tubers, sufficient to cause considerable loss of the crop unless precautions are taken to disinfect the cutting knife, sacks and planter. The cutting knife is probably the most important instrument in the dissemination of the causal agent to uninfected tubers since each seed piece cut makes contact with the knife while other potential means of spread such as infected cut tuber in a sack of healthy seed pieces, an infected planter pick, or a contaminated sack will contact only a relatively few seed pieces.

This paper reports results of investigations through two growing seasons on: (a) the effect of the addition of wetting agents on the disinfecting power of solutions of mercuric chloride and calcium hypochlorite, (b) the use of mercuric chloride or calcium hypochlorite for disinfection of the stationary double-edged knife (7), (c) the value of various disinfectants to prevent the spread of ring rot bacteria by the rotaary blade (2), (d) the comparative amount of ring rot transmissible by the surface of the cutting table under different knife disinfecting practices, and (e) the value of prompt submersion of inoculated seed pieces in a disinfectant solution as a method of ring rot control.

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FIELD TESTS 1946

Materials and General Methods

A supply of non certified Red McClure potatoes was divided into 33 lots of approximately 115 tubers each. From each lot 12 to 14 tubers were selected at random to supply 400 tubers which were planted without cutting to determine the amount of ring-rot infection present in this lot of seed. The remainder of each lot was used for tests of disinfection and transmission of the organism.

Knife blades or table surfaces were smeared with a ring-rot infected tuber as a source of inoculum at the beginning of each treatment and were recontaminated after each tenth tuber treated.

After treatment each lot was subdivided at random into 5 sub-lots of 40 seed pieces each and planted in 5 randomized blocks. Potatoes were cut from the 5th to the 8th of May and planted on the 9th and 10th of May.

Stand counts and the number of ring-rot infected plants in each plot were determined from the 29th of August to the 1st of September. The determination of ring rot infection was based on aerial symptoms plus the stem-ooze test (3).

RESULTS AND DISCUSSION

Table 1 lists all the treatments employed, the average number of plants per plot at the end of the season, and the mean number of ring-rot plants per plot for each treatment. An analysis of variance applied to the stand data shows that there is no significant reduction in stand due to any treatment when compared to the mean of the ten plots of uncut seed. Consequently, the number of infected plants per treatment is used as a basis for statistical analysis of the disease data.

THE ROTARY BLADE

The rotary blade was used to test the efficacy of various disinfectants, some of which were to be used on the stationary knife, since it has been established that spread of the ring-rot organism *via* the cutting knife can be prevented by disinfecting the rotating blade with boiling water or 0.2 per cent mercuric chloride (1), (4), (5), (8).

Included in the test were boiling water, 0.2 per cent mercuric chloride with and without Vatsol OT, Roccal and Hyamine 1622, each at concentrations of 1 per cent of the active ingredient, and BK in weight sufficient to yield 2,000 ppm of chlorine in solution. Other concentrations of chlorine ranging down to 25 ppm were also tested.

Many disinfectant materials are comparatively effective in reducing the spread of the ring-rot organism. However, a knife disinfectant can

TABLE 1.—*Stand and number of ring-rot plants — 1946 Field tests. 5-plot averages*

Knife	Knife Disinfectant	Direction[1] of Cut	Rate of Flow of Disinfectant	Ave. No. Plants per Plot		Ave. No. Ring-rot Plants per Plot	
None	Uncut tubers		—	37.8	37.6	1.0	1.5
None	Uncut tubers		—	37.4		2.0	
Rotary blade	None	—	—	38.2		36.0^{0}	
" "	Boiling water	—	—	39.0		1.2	
" "	$HgCl_2$ 1-500	—	—	39.2		3.4	
" "	$HgCl_2$ 1 500 + Vatsol OT[2]	—	—	39.0		4.2**	
" "	Roccal (1-9)[3]	—	—	38.0		19.8^{0}	
" "	Hyamine 1622 1-24[4]	—	—	37.2		29.8^{0}	
" "	Cl 2000 ppm[5]	—	—	39.2		6.0**	
" "	Cl 1000 ppm[5]	—	—	37.6		23.8^{0}	
" "	Cl 500 ppm[5]	—	—	38.4		30.0^{0}	
" "	Cl 250 ppm[5]	—	—	38.4		36.4^{0}	
" "	Cl 200 ppm[5]	—	—	38.4		33.6^{0}	
" "	Cl 150 ppm[5]	—	—	38.2		36.8^{0}	
" "	Cl 100 ppm[5]	—	—	38.0		33.0^{0}	
" "	Cl 50 ppm[5]	—	—	39.6*		38.0^{0}	
" "	Cl 25 ppm[5]	—	—	37.2		35.2^{0}	
Stationary Double-Edged	None	1-way	—	39.2		35.4^{0}	
" "	$HgCl_2$ 1-500	1-way	1 qt. per hr.	37.6		3.6*	
" "	$HgCl_2$ 1-500	1-way	2 qt. per hr.	39.2		4.4**	
" "	$HgCl_2$ 1-500	2-way	2 qt. per hr.	37.8		2.6	
" "	$HgCl_2$ 1-500 + Vatsol OT[2]	1-way	2 qt. per hr.	39.0		3.0	
" "	$HgCl_2$ 1-500 + Vatsol OT[2]	2-way	2 qt. per hr.	39.0		1.6	
" "	Cl 2000 ppm[5]	1-way	2 qt. per hr.	38.2		14.0^{0}	

Knife	Knife Disinfectant	Knife Contaminated	Table Surface Contaminated	Ave. No. Plants per Plot	Ave. No. Ring-rot Plants per Plot
Rotary blade	$HgCl_2$, 1-500	no	yes	38.6	5.2**
" "	$HgCl_2$, 1-500	yes	yes	38.4	3.2
" "	Boiling water	no	yes[6]	38.8	9.4**
" "	Boiling water	no	yes[7]	38.6	38.0[0]
			Disinfectant Dip		
Stationary Double-Edged	None	yes	$HgCl_2$, 1-500[8]	37.0	15.8[0]
" "	None	yes	Cl, 2000 ppm[5,8]	39.0	18.6[0]

Difference required for significance—		
Comparing 5-plot means with 10-plot mean of whole tuber checks		
5 per cent point (Odds 19:1)	1.62	1.96
1 per cent point (Odds 99:1)	2.15	2.61
Comparing any pair of 5-plot means		
5 per cent point (Odds 19:1)	1.88	2.26
1 per cent point (Odds 99:1)	2.48	3.01

[0]Number of ring rot plants obviously excessive, hence not included in analysis of variance.
*Exceeds mean of whole-tuber checks, odds 19:1.
**Exceeds mean of whole-tuber checks, odds 99:1.
[1]1-way—all tubers pass the knife blade in one direction; 2-way—alternate tubers pass knife blade in opposite directions.
[2]Vatsol OT85, (sodium dioctyl sulfo-succinate) 1 teaspoon per gallon.
[3]Mixture of alkyl-dimethyl-benzyl ammonium chlorides—1 per cent of active ingredient.
[4]Di-isobutyl phenoxy ethoxy dimethyl benzyl ammonium chloride—1 per cent of active ingredient.
[5]Commercial BK solution, tested with Taylor Chlorine slide colorimeter.
[6]Metal plate above boiling water, hot.
[7]Metal plate, not over boiling water, cold.
[8]Cut seed pieces immersed immediately on cutting.

be said to give satisfactory control of ring rot only if sample lots of potatoes cut while using that disinfectant develop no more ring-rot plants than the uncut tubers.

Of the disinfectant materials tested on the rotary blade all except boiling water and 0.2 per cent mercuric chloride permitted a significant increase in the number of ring-rot plants when compared with the uncut tubers. The number of ring-rot plants was obviously excessive in lots cut while using chlorine concentrations below 2000 ppm or the quaternary ammonium compounds, Roccal and Hyamine 1622. The analysis of variance applied to the remaining treatments showed the two treatments, mecuric chloride (0.2 per cent) plus Vastol OT and 2000 ppm of chlorine to be unsatisfactory as a control in this test.

It may be noted that the number of ring-rot plants in cut-seed lots is rather consistently greater than in the uncut tuber lots even though the differences are often not statistically significant. This may have resulted from contamination of fresh cut seed-piece surfaces by ring-rot bacteria from infected seed pieces mixed with the healthy ones in sacks or boxes after cutting. This uncontrolled source of statistical error would tend to increase the amount of ring rot in cut seed trials beyond the amount normally carried by the seed source.

The Stationary Double-Edged Knife

Tests, in 1945 (5), of the stationary double-edged blade revealed an anomalous situation in that an increase in rate of flow of the disinfectant from one quart to two quarts per hour decreased the effectiveness of ring-rot control. It appeared that there might be two possible explanations of this tendency: (1), the possibility that the surface tension of the liquid would tend to draw it into flow lines as the volume increased and hence leave part of the blade uncovered; and, (2), that since all the tubers in the test were of 2-seed-piece size and were cut in the same direction across the knife they would tend to push the disinfectant aside, and perhaps, build up starch deposits which would deflect the flow away from the edge of the knife. Means of testing these hypotheses were accordingly devised, one set to compare the effect of one-way and two-way cutting, and another set to test the effect of the addition of Vatsol OT, a wetting agent, to the disinfectant on both one- and two-way cutting at the higher rate of flow of disinfectant.

Those lots in which the tubers were cut in alternate directions across the knife were not significantly different from the uncut tubers in the number of ring rot plants produced. There was also no significant difference in number of ring rot plants between lots cut with and without the addition of the wetting agent to the disinfectant. However, the lots

which were cut without the wetting agent in the disinfectant differed significantly from the uncut tubers in number of ring rot plants whereas those cut after the wetting agent was added did not. This fact suggests that the addition of the wetting agent improved the effectiveness of ring rot control on this knife.

Table Surface Contamination

Tests, in 1945 (5), of the amount of spread of the ring-rot organism by contact of the cut surface of the seed piece with contaminated table surfaces adjacent to the cutting knife revealed a significant increase in the number of ring-rot plants though the amount was smaller than expected. In these tests the rotary blade on which the tubers were cut was disinfected with 0.2 per cent mercuric chloride presumably leaving a film of the disinfectant on the seed pieces.

Tests were included in 1946 in which seed pieces cut on the rotary blade revolving in 0.2 per cent mercuric chloride or in boiling water were exposed to infection by rubbing the cut surfaces over metal plates smeared with inoculum from a ring-rot infected tuber. For one lot of seed pieces cut using boiling water as the disinfectant, the inoculum was spread over a hot metal plate heated by steam rising from the tank of boiling water; whereas for a second lot the inoculum was spread on a similar metal plate not so heated. The same cold metal plate was used to inoculate the seed pieces cut using mercuric chloride as the knife disinfectant. All except one of the lots so treated developed excessive amounts of ring rot. Both lots cut on the knife revolving in 0.2 per cent mercuric chloride developed significantly less infection than those for which the knife disinfectant was boiling water and one of these was not significantly different from the uncut tuber controls.

Immersion of Seed Pieces

In early tests at this Station attempts to control ring rot by dipping seed pieces in mercuric chloride solution after cutting them on a contaminated knife were made without success. In these tests a moderate amount of time elapsed between cutting and immersion. In the present tests two lots of tubers were cut on a contaminated double-edged knife without disinfection, the seed pieces being dropped directly from the knife into the disinfectant (0.2 per cent mercuric chloride in one test, 2000 ppm of chlorine in the other).

Ten tubers were cut and dropped into the disinfectant in quick succession and then immediately removed, the whole operation requiring approximately 40 seconds, after which the cutting blade was re-contamin-

ated and another 10-tuber lot was treated until a total of 100 tubers had been cut.

Plots from both treatments ($HgCl_2$ and Cl) showed an obviously excessive number of ring-rot plants.

Field Tests—1947

Materials and General Methods

Following the same technique as described above 16 lots of non-certified Red McClure potatoes were separated, two consisting of 200 tubers each to be planted without cutting, the remaining 14 lots consisting of 100 tubers each for transmission and disinfection tests on the rotary blade and the double-edged stationary knife. Disinfectants tested on the rotary blade were 0.2 per cent mercuric chloride and chlorine from calcium hypochlorite at 5000 ppm. Both disinfectants were used with and without Triton X300, a wetting agent. The two mercuric chloride solutions were also used to disinfect the double-edged stationary knife with two styles (directions) of cutting and at two rates of flow. Knife blades were contaminated in the same way as previously described. Tests of both cutters were made without disinfection to ascertain the efficiency of the inoculation technique. Seed pieces of all lots were assigned at random to five sub-lots and were planted in 5 randomized blocks. Chlorine solutions were tested with a Taylor Chlorine Slide Colorimeter to determine the amount of chlorine present. The tubers were cut on the 14th and 15th of May and planted on the 17th. Stand counts and the number of ring-rot plants per plot were determined from the 28th to the 30th of August.

Results and Discussion

Table 2 shows summaries of the data obtained from this plot. An analysis of variance of the data on stand shows no significant differences between treatments. Since the amount of ring-rot infection revealed in the uncut tubers was extremely low the degree of infection was treated as a Poisson variable and the formula

$$Px = e^{-Np}\frac{(Np)^{x}}{x!}$$

(6) was used to determine the maximum number of ring-rot plants permissible in a treatment population corresponding to a probability of .01 that the ring rot present was the result of chance. In the range of populations per treatment involved in this experiment and with approximately 0.5 per cent ring-rot infection in the seed, a total of four ring-rot plants in any treatment is excessive, corresponding to a probability of .05; a total of five ring-rot plants is excessive, corresponding to a

TABLE 2.—*Stand and number of ring-rot plants—1947 field tests of the rotary and stationary double-edged knife*

Knife	Knife Disinfectant	Rate of Flow of Disinfectant	Direction of Cut[1]	Ave. No. of Plants per Plot (5-Plot Ave.)	Total No. Ring-Rot Plants (5-Plots)
None	Uncut tubers	—	—	39.4 } 39.0	0.0
None	Uncut tubers	—	—	38.6	2.0
Rotary blade	$HgCl_2$—1-500	—	—	38.2	0.0
Rotary blade	$HgCl_2$—1-500 + Triton X300[2]	—	—	39.4	1.0
Rotary blade	Cl 5000 ppm[3]	—	—	39.8	1.0
Rotary blade	Cl 5000 ppm + Triton X300	—	—	38.8	1.0
Rotary blade	None	—	—	39.6	157.0**
Stationary					
Double-edged	$HgCl_2$ 1-500	1 qt. per hr.	1-way	39.0	1.0
" "	$HgCl_2$ 1-500	1 qt. per hr.	2-way	39.6	1.0
" "	$HgCl_2$ 1-500	2 qt. per hr.	1-way	39.4	1.0
" "	$HgCl_2$ 1-500	2 qt. per hr.	2-way	37.8	0.0
" "	$HgCl_2$ 1-500 + Triton X300	1 qt. per hr.	1-way	39.8	5.0**
" "	$HgCl_2$ 1-500 + Triton X300	1 qt. per hr.	2-way	38.8	0.0
" "	$HgCl_2$ 1-500 + Triton X300	2 qt. per hr.	1-way	39.2	0.0
" "	$HgCl_2$ 1-500 + Triton X300	2 qt. per hr.	2-way	39.0	0.0
" "	None			38.6	81.0**
Difference required for significance—					
Comparing 5-plot means with 10-plot mean of uncut tubers					
5 per cent point, Odds 19:1				1.24	
1 per cent point, Odds 99:1				1.65	
Number of ring-rot plants required for significance (Poisson distribution)					
5 per cent point, Odds 19:1					4.0
1 per cent point, Odds 99:1					5.0

**Exceeds the uncut tuber controls, odds 99:1.

[1] 1-way, all tubers pass the knife in one direction; 2-way, alternate tubers pass the knife in opposite directions.

[2] Sodium salt of alkylated aryl polyether sulfate, ½ ml. per gallon.

[3] Commercial BK solution, tested with Taylor Chlorine Slide colorimeter.

probability of .01. In this test the number of ring-rot plants in only the inoculated but non-disinfected lots and one other, mercuric chloride plus Triton 300, 1 quart per hour with one-way cutting on the stationary double-edged knife, exceeded the number of ring-rot plants in the uncut seed lots at the 1 per cent level of significance (odds 99:1).

Summary and Conclusions

Tests of the disinfection of the double-edged stationary knife with 0.2 per cent mercuric chloride indicated that the addition of a wetting agent to this disinfectant probably results in more effective ring-rot control on this knife.

Disinfectant tests on the rotary blade showed satisfactory ring-rot control through the use of 5000 ppm of chlorine, 5000 ppm of chlorine plus Triton X300, 0.2 per cent mercuric chloride, 0.2 per cent mercuric chloride plus Triton X300, or boiling water. Unsatisfactory disinfection resulted from the use of (1) the quaternary ammonium compounds Hyamine 1622 and Roccal, each at 1 per cent of the active ingredients, (2) 0.2 per cent mercuric chloride plus Vatsol OT and (3) calcium hypochlorite solutions containing chlorine in concentrations of 2000 ppm or less.

Tests were made of the dissemination of ring-rot bacteria by contact of the fresh-cut seed-piece surface with a contaminated table surface after using mercuric chloride or boiling water as a knife disinfectant. All test lots, with the exception of one, showed excessive numbers of ring-rot plants.

Prompt immersion of seed pieces in disinfectant solution (0.2 per cent mercuric chloride or 2000 ppm of chlorine) after inoculation with contaminated cutting knife materially reduced the number of ring-rot plants although ring rot resulting from both treatments was far in excess of that from uncut tuber lots.

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